



PRESQUE ISLE BAY REMEDIAL ACTION PLAN 2002 UPDATE





Mark Schweiker
Governor

A Message from the Governor

Pennsylvania has access to one of the world's greatest natural resources — Lake Erie. The management of this unique resource is a true success story — two nations, two provinces, eight states and a myriad of local municipal governments, through cooperation and partnership, working together for the common good.

Pennsylvania is proud to be a part of this diverse group. On behalf of the Department of Environmental Protection and the Presque Isle Bay Public Advisory Committee, I am pleased to recommend a change in designation for Presque Isle Bay from an Area of Concern to a Recovery Stage. Such an astounding improvement is a first for the United States and only the second of the 43 such Areas of Concern to achieve this goal.

In 1995, Gov. Tom Ridge and I created the Office of the Great Lakes to devote full-time attention to Great Lakes issues. Pennsylvania's expanding participation has promoted not only our own environmental objectives, but also those of the entire Great Lakes community.

Lake Erie and Presque Isle Bay have a long and illustrious history as one of the oldest working ports on the Great Lakes. The legacy of this industrial past was an unswimmable bay, uneatable fish, and a city headed for economically trying times.

Thanks to the hard work and determination of a dedicated group of citizens, industries, and governments, a wake-up call was sounded in the 1980s, and the Erie County Environmental Coalition was formed. That wake-up call was well heeded, and the result has been new life and vitality for the Lake, Bay and the City of Erie. Today, Presque Isle Bay is a recreation and tourist mecca with one of the most-visited state parks in Pennsylvania.

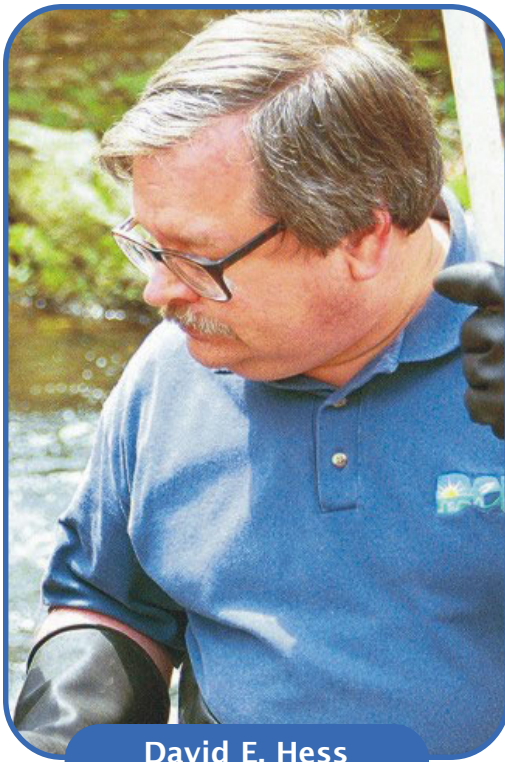
The designation of the Presque Isle Bay Area of Concern to a Recovery Stage is a milestone worth celebrating. My congratulations to all who have worked hard to achieve this goal. However, our work in restoring the Bay to its full environmental and economic well-being is not done.

It will take the commitment of all the Bay's users to maintain and protect a healthy, productive Bay. Pennsylvania is continuing its commitment to Lake Erie and Presque Isle Bay with the development of the \$25 million Presque Isle Center. This "green" center will be devoted to research, education and monitoring of the health of the Lake, Bay and their watersheds.

Thank you to the Pennsylvania communities, businesses and residents who are protecting and preserving these most valuable resources.

A handwritten signature of Mark Schweiker in black ink. The signature is written in a cursive style, with the first name 'Mark' being more prominent and the last name 'Schweiker' following in a fluid, connected script.





David E. Hess
DEP Secretary

Celebrating a New Milestone

The story of Presque Isle Bay is full of ordinary people doing extraordinary work.

From the initial petition that concerned Erie area citizens and the Erie County Environmental Coalition made to the International Joint Commission in 1991 to designate the Bay an Area of Concern, to the recent recognition of the improvements in the quality of the Bay's environment, the Erie community and the Commonwealth have identified Presque Isle Bay as one of Pennsylvania's most valuable resources.

The hard work by all partners — the Presque Isle Bay Public Advisory Committee, watershed groups, DEP employees — has resulted in a Bay that is on the road to environmental recovery. I want to thank each and every person involved for your stewardship of the Bay.

Appropriately on Earth Day 2002, members of the Public Advisory Committee recommended the Department of Environmental Protection designate Presque Isle Bay as an Area of Concern in a Recovery Stage. Based on the efforts of all the partners, DEP approved the request.

But, there is still more work to be done to ensure that Presque Isle Bay continues to improve and remains a place where all Pennsylvanians can fish, boat and enjoy its natural beauty for many years to come.

The efforts of the Public Advisory Committee, the U.S. Environmental Protection Agency, the Erie County Conservation District, the City and County of Erie, and all of the organizations focusing on the Bay and its watershed will be needed to take the Bay to the next step.

I look forward to continuing the work we've begun to restore Presque Isle Bay.

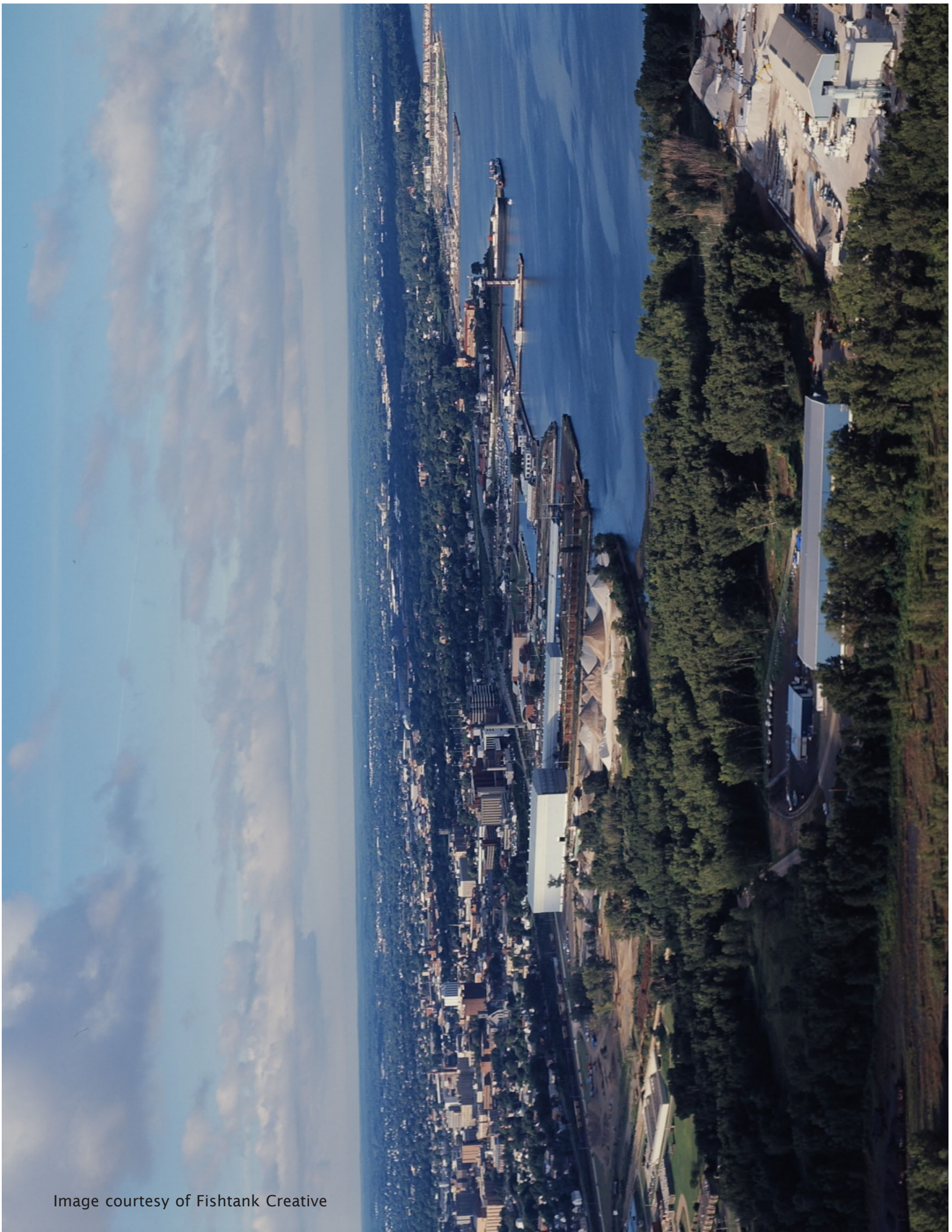


Image courtesy of Fishtank Creative



Acknowledgements



This milestone would not have been possible without the combined efforts of a number of people. Thanks to Bob Wellington of the Erie County Department of Health; Eric Obert of the Pennsylvania Sea Grant; Dr. Richard Diz from Gannon University; and Jim Grazio and Geoff Bristow from DEP for their work on the fish and sediment studies.

The contributions of Sister Pat Lupo of Glinodo Center; Tom Maggio of the Erie-Western Pennsylvania Port Authority; and Jim Tabor, John Booser and Art Provost of DEP were invaluable to this report.


The work of Bob Light and Anne Danielski of the Pennsylvania Sea Grant and Chris Pavlekovsky of DEP in editing, formatting and polishing this update is greatly appreciated. Thanks also to Lori Boughton of DEP for leading the effort to put this document together.

Jim Rozakis and the late Peter Yeager of DEP deserve recognition for guiding the early efforts that put Presque Isle Bay on the road to environmental recovery.

Thanks to Mike Zimmerman, Kim Bontrager and many other DEP employees who brought focused attention, resources and results to the Bay's problems. Lastly, this milestone would not have been reached without the leadership and direction of Kelly Burch, Chairman of the Public Advisory Committee and Director of DEP's Northwest Regional Office.



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EXECUTIVE SUMMARY



The Pennsylvania Department of Environmental Protection (DEP) recommends, with the concurrence of the Public Advisory Committee (PAC), that the Presque Isle Bay Area of Concern (AOC) be designated in the Recovery Stage. This designation recognizes the improvements made to the environmental health of the Bay during the ten years since its listing as an AOC. Being in a Recovery Stage means that monitoring rather than further remedial action is necessary to maintain and restore the beneficial uses identified for the Bay. This report summarizes the results of studies on fish and sediments, and the work done by numerous organizations in the Bay and its watershed that has led DEP and the PAC to make this recommendation.

Presque Isle Bay was designated the 43rd Great Lakes Area of Concern in 1991 after concerned citizens from Erie petitioned for its inclusion. The AOC designation requires a Remedial Action Plan (RAP) for the Bay to provide a framework for the activities needed to restore impaired beneficial uses. Preliminary studies followed by a RAP in 1993 and an update in 1995 identified two beneficial use impairments for the Bay: (1) fish tumors and other deformities and (2) restrictions on dredging activities.

DEP and its partners have focused on the Bay's brown bullhead population and sediments as the environmental indicators to better define the problems and develop solutions to address the two beneficial use impairments.

Studies have attributed tumors in brown bullheads to viruses, chemical exposure to carcinogens such as polycyclic aromatic hydrocarbons (PAHs), and fish age. Tumors in the Bay's brown bullheads have steadily decreased from 86 percent of the population exhibiting external tumors in 1990 to just 19 percent in 1999. The incidence of liver tumors, thought to be a better indicator of environmental contamination, also declined over this period. In fact, liver tumor rates were found comparable to brown bullheads from non-polluted reference lakes. Overall, the studies found the population to be stable and reproducing.

EXECUTIVE SUMMARY



The Bay's sediments are contaminated with heavy metals and PAHs as a result of its urban setting, physical characteristics, and historical receipt of industrial and domestic wastewater. The concentrations of PAHs found in the sediments were higher than from most coastal environments. However, no clear impact on the macroinvertebrates in the Bay has been found. Additionally, no direct correlation has been established between sediment contamination and fish tumors. From an economic perspective, there are no plans for the foreseeable future to dredge the contaminated sediments for navigational purposes.

Changes are taking place in the amount of pollutants entering the Bay and becoming entrapped in its sediments. Examples of such changes include the improvements to the City of Erie's wastewater treatment, conveyance, and collection system, and the transformation of the bayfront from an industrial to a commercial and recreation center. Coupled with the assessment, cleanup and education work done by DEP's many partners in the watershed, the amount of contaminants entering the Bay has been greatly reduced.

Based upon the lack of correlation between PAHs and other sediment contaminants with impacts on the benthic community and fish, the decline in fish tumor rates, the absence of a need for navigational dredging, and reduction in pollutant loading to the Bay, DEP has concluded that the two beneficial use impairments identified for the Bay are recovering. DEP is committed to continued monitoring of the Bay sediments and brown bullheads and supporting the efforts of its partners in the watershed to achieve and maintain the restored beneficial uses.



INTRODUCTION

The Pennsylvania Department of Environmental Protection (DEP) recommends that the status of the Presque Isle Bay Area of Concern (AOC) be changed from the Remediation Stage to the Recovery Stage. On April 22, 2002, the Presque Isle Bay Public Advisory Committee reached consensus and recommended to DEP that the improvements made to the environmental health of the Bay be recognized and the status changed to a Recovery Stage.

DEP concurs with this recommendation and is seeking the agreement of the United States Environmental Protection Agency (USEPA) on this change in designation. The recommendation recognizes that the impaired beneficial uses identified for the Bay are responding to the actions taken and that monitoring rather than further active remediation of the Bay is necessary to achieve and maintain the restored beneficial uses.

The United States Department of State designated Presque Isle Bay as the 43rd AOC on January 30, 1991, under the terms of the Great

DEP recommends that the status of Presque Isle Bay be changed to the Recovery Stage

Lakes Water Quality Agreement. As an AOC, the Bay is the focus of prioritized ecosystem restoration and management activities. The AOC designation requires a Remedial Action Plan (RAP) for the Bay to provide a framework for the activities needed to restore impaired beneficial uses. In January 1993, a RAP was issued identifying beneficial use impairments in the Bay, sources of pollution, and data gaps. An update followed in 1995, documenting new work completed and making revisions to the original RAP based upon additional studies.


This document supplements the RAP and 1995 update, providing further updates on the condition of the Bay and chronicling the activities undertaken since the 1995 update to characterize and restore impairments. It gives a brief overview of previous studies, presents the findings of the



latest fish and sediment studies, and summarizes work done by the DEP and its partners to restore the health of the Bay and its watershed. The results of the studies and the work done in the watershed provide the basis for the recommendation to designate Presque Isle Bay as an AOC in the Recovery Stage.



BACKGROUND



By virtue of its 63 miles of coastline on Lake Erie, Pennsylvania has access to one of the world's greatest natural resources and is a member of the Great Lakes community. Historical use of the Great Lakes as a shipping route and as a repository for industrial waste and sewage degraded the environmental quality of the Lakes' natural resources.

Management and preservation of the Great Lakes ecosystem is a binational, multi-media effort. Two agreements between the United States and Canada form the governing framework for monitoring and improving the quality of the Great Lakes resources. First, the 1909 Boundary Waters Treaty set the tone with the creation of the International Joint Commission (IJC). The IJC is an independent, joint Canadian and American federal government agency that provides oversight of the shared water resources between the two countries. Various boards, task forces, and committees advise the IJC.

Second, the Great Lakes Water Quality Agreement (GLWQA) signed in 1972 expressed

the commitment of the United States and Canada to restore and maintain the chemical, physical, and biological integrity of the Great Lakes. This agreement was revised in 1978, and again in 1987, to reflect changing conditions and to bring emphasis to the toxic chemical problems in the Lakes.

The 1978 revision introduced for the first time the concept of using an ecosystem approach to manage the Lakes. Annex 2 of the 1987 Protocol listed 14 guidelines to identify beneficial use impairments in evaluating the health of the Lakes (Table 1). These 14 guidelines were used to identify geographical areas of concern, or AOCs, that failed to meet the general or specific objectives of the GLWQA and where the failure has caused or is likely to cause impairment of one or more beneficial uses. Forty-two AOCs within the Great Lakes (Figure 1) were initially designated based upon an analysis of environmental data and beneficial use impairments. Presque Isle Bay was designated the 43rd AOC in 1991.



Table 1. AOC Listing Guidelines (IJC, 1991)

Guideline	Impairment
1. Restrictions on fish and wildlife consumption	When contaminant levels due to input from the watershed or wildlife populations exceed current standards, objectives or guidelines, or public health advisories are in effect for human consumption.
2. Tainting of fish and wildlife flavor	When ambient water quality standards, objective, or guidelines for the anthropogenic substances(s) known to cause tainting, are being exceeded or survey results have identified tainting of fish or wildlife flavor.
3. Degraded fish and wildlife populations	When fish and wildlife management programs have identified degraded fish or wildlife populations due to a cause within the watershed.
4. Fish tumors or other deformities	When the incidence rates of fish tumors or other deformities exceed rates at unimpacted control sites or when survey data confirm the presence of liver tumors in bullheads or suckers.
5. Bird or animal deformities or reproductive problems	When wildlife survey data confirm the presence of deformities or other reproductive problems in sentinel wildlife species.
6. Degradation of benthos	When benthic macroinvertebrate community structure significantly diverges from unimpacted control sites of comparable physical and chemical characteristics.
7. Restrictions on dredging activities	When contaminants in sediments exceed standards, criteria, or guidelines such that there are restrictions on dredging or disposal activities.
8. Eutrophication or undesirable algae	When there is persistent water quality problems attributed to cultural eutrophication.
9. Restriction-drinking water consumption-taste/odor problems	When treated drinking water supplies are impacted to the extent that: 1) densities of disease-causing organisms or concentrations of hazardous or toxic chemicals or radioactive substances exceed human health standards, objectives, or guidelines; 2) taste and odor problems are present; or 3) treatment needed to make raw water suitable for drinking is beyond the standard treatment used in comparable portions of the Great Lakes which are not degraded.
10. Beach closing	When waters, which are commonly used for total-body contact or partial-body contact recreation, exceed standards, objectives, or guidelines for such use.
11. Degradation of aesthetics.	When any substance in water produces a persistent objectionable deposit, unnatural color or turbidity, or unnatural odor.
12. Added costs to agriculture or industry.	When there are additional costs required to treat the water prior to use for agricultural purposes or industrial purposes.
13. Degradation of phytoplankton and zooplankton populations.	When phytoplankton or zooplankton community structures significantly diverge from unimpacted control sites of comparable physical and chemical characteristics.
14. Loss of fish and wildlife habitat.	When fish and wildlife management goals have not been met as a result of loss of fish and wildlife habitat due to a perturbation in the physical, chemical, or biological integrity of the Boundary Waters, including wetlands.

To track and measure progress in terms of environmental health, six categories following a sequence for investigation, problem identification, and resolution are used. The categories identify the status of the information base, programs that are underway to fill the information gaps, and the status of remedial efforts. Problem resolution is considered complete

when evidence can be presented that the full complement of beneficial uses has been restored and the site can be removed from the AOC list (i.e., delisted). Public involvement requirements were added with the 1987 Protocol to ensure participation during the investigation, remediation, and monitoring of the AOCs beneficial use impairments.

Figure 1.
Great Lakes Areas of Concern



Image courtesy of USEPA's Great Lakes National Program Office

A Remedial Action Plan is required for each of the AOCs. RAPs are submitted to the IJC for review and comment at three stages: 1) when problems have been defined; 2) when remedial and regulatory measures are selected; and 3) when monitoring indicates that beneficial uses are restored. Although considerable work and progress has been made in identifying impairments and taking

action to address them, only one of the AOCs, Collingwood Harbour, Ontario, has been removed from the AOC list. A recommendation to delist a second AOC, Severn Sound, Ontario, has been made to the IJC.

To recognize improvements in the environmental health of AOCs that are not ready for delisting, a new phase for AOCs was added

called a “Recovery Stage”(IJC, 2001). During the recovery period, the AOC ecosystem is responding to actions taken. AOCs in this stage do not require further active remediation to address beneficial use impairments, but monitoring is necessary to ensure that conditions continue to improve before delisting.

The local public must be satisfied that all reasonable and practical


implementation has occurred to address the sources of environmental impairments with present day technology.

Additionally, a monitoring plan and process must be in place to maintain the health of the ecosystem and respond to future development pressures and new environmental technologies so that the environmental recovery is sustainable.

During the recovery period, the AOC ecosystem is responding to actions taken. AOCs in this stage do not require further active remediation to address beneficial use impairments, but monitoring is necessary to ensure that conditions continue to improve before delisting.



HISTORY

A horizontal line with ten small fish icons spaced evenly along it.

Located on the southern shore of Lake Erie, Presque Isle Bay is the oldest harbor on the Great Lakes. The City of Erie has grown up around this port. The Presque Isle Peninsula, a recurved sand spit on Lake Erie, forms the Bay. Most of the shoreline of the Bay is fronted by the City of Erie. The western and northern shorelines are bordered by Presque Isle State Park (Figure 2).

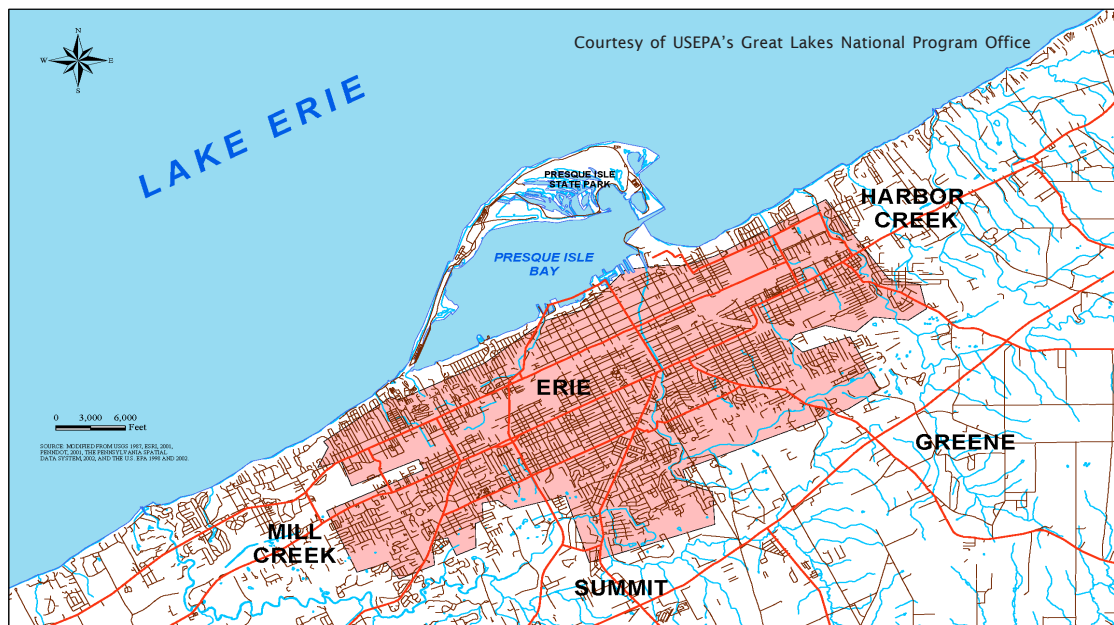
The Bay's watershed is approximately 25 square miles in area and includes much of the City of Erie as well as portions of Millcreek, Summit, Greene, and Harborcreek Townships. Over time, much of the watershed draining into the Bay has become urbanized with heavy manufacturing industries coexisting within residential and commercial neighborhoods.

As with other parts of the Great Lakes, past waste disposal practices resulted in the discharge of industrial and domestic wastewater to the Bay or to the streams and tributaries draining into the Bay. Until changes were made to the City of Erie's wastewater treatment,

collection, and conveyance system, untreated industrial, commercial, and residential wastewater escaping from combined sewer overflows was discharged to the Bay. Because most of its watershed is a developed, urban area, the Bay received high concentrations of pollutants from stormwater runoff. While many pollutants released to the Bay from such past practices have decayed through natural biodegradation processes, substances like heavy metals and more resistant organics remain in the sediments. Additionally, the geography and geology of the Bay make it a natural "settling" basin for solids. Most of the pollutants that enter the Bay in runoff become entrapped in the sediments.

As early as 1984, the United States Fish and Wildlife Service (USFWS) began receiving reports of brown bullheads (*Ameriurus nebulosus*) with external sores and lesions being caught by fishermen from Presque Isle Bay. In January 1988, members of the Erie County Environmental Coalition petitioned the Science Advisory Board of the IJC to designate the Bay as an Area of

Figure 2: Presque Isle Bay Watershed



Concern. Formed in 1983, the Coalition included members from various local organizations such as the League of Women Voters, the Erie County Sportsman Association, the Benedictine Sisters, and the Presque Isle Audubon Society. The intent of the Coalition in seeking the designation was to focus attention and to secure funding for the Bay in order to enhance the environmental and economic quality of life in the watershed.

In December 1988, Erie's City and County governments formed the Erie Harbor Improvement Council. Members were appointed and included representatives from business, industry, academia, development, government, and civic and environmental groups. The goal of the council was to clean up Presque Isle Bay by the year 2008 - A Swimmable Bay in 20 years.

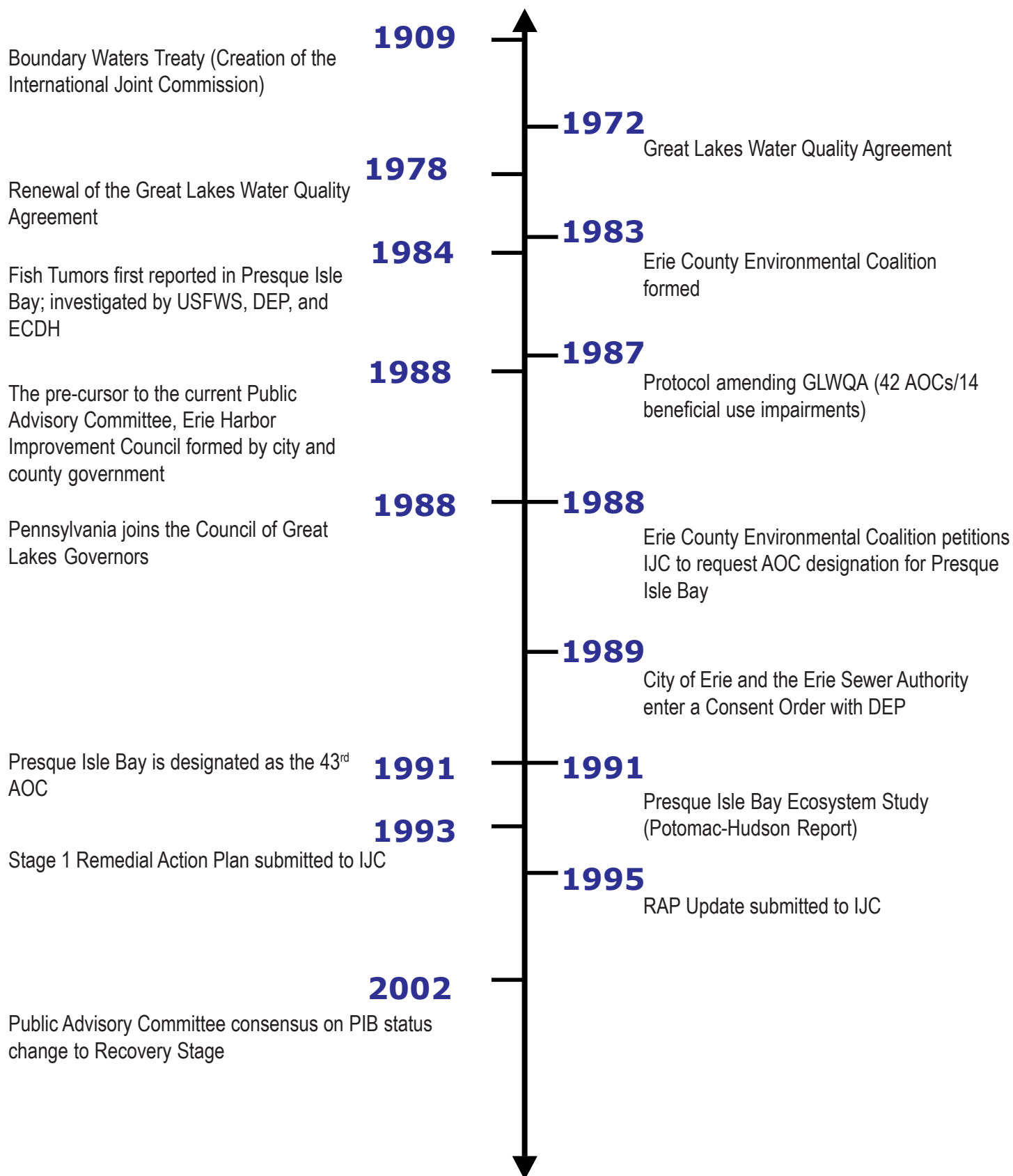
The objectives of the Council were to ensure that Pennsylvania met its responsibilities under the GLWQA and to ultimately provide an action plan to clean up the Bay, restore impaired uses, and enhance economic revitalization.

Presque Isle Bay was designated the 43rd AOC in 1991 in response to the concerns raised by the Coalition (Figure 3). The Erie Harbor Improvement Council was dissolved in 1991 and its members became the DEP Public Advisory Committee for the Bay. The reasons for listing the Bay were not cited in the designation and so the first step was to determine which of the IJC's 14 beneficial uses were actually or potentially impaired.

Using existing data and information, a preliminary analysis identified 16 pollutants of



Figure 3. Timeline of Events





concern in the sediment, including ten heavy metals (arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc), nutrients (phosphorus and total kjeldahl nitrogen), chemical oxygen demand, cyanide, oil and grease, and volatile organics. Polycyclic aromatic hydrocarbons (PAHs) were also found in the sediments (Potomac-Hudson, 1991). No impairments to the water column or fish and wildlife were indicated. Based upon a limited analysis of existing data, DEP believed that two of the 14 beneficial uses were potentially impaired: (1) fish tumors and other deformities and (2) restrictions on dredging activities.

In 1993, a Remedial Action Plan was submitted to the IJC. The RAP analysis confirmed what was already known about the Bay. Available data was compared to the IJC's AOC Listing Guidelines (IJC, 1991) to identify impaired beneficial uses. Analysis of data generated prior to 1990 clearly indicated impairments based upon the guidelines for fish tumors and other deformities and restrictions on dredging activities. Additionally, the available data, or lack of data, left questions regarding two other potential impairments: (1) degradation of phytoplankton and zooplankton populations and (2) beach closings.

Based upon the impaired uses evaluation, the only pollutants of concern identified were sediment contaminants. No water column impairments were indicated. Fish impairments, if environmentally caused, were believed related to the sediment contamination; however, no correlation was made between sediment contamination and tumor rates.

Two of the 14 beneficial uses were potentially impaired: (1) fish tumors and other deformities and (2) restrictions on dredging activities.

Sediment data were compared with the current applicable standards (USEPA, 1977). The presence of the 16 pollutants of concern identified in the preliminary report was confirmed. In addition, although no standards for PAHs existed, sediment levels of these compounds were thought to be elevated based on other Great Lakes sites. Therefore, sediment PAHs were included as a pollutant of concern.

An update to the RAP was submitted to the IJC in 1995. The update summarized new information and data on the beneficial use impairments and responded to comments and questions received from the IJC and the USEPA on the RAP. Once again, studies done by DEP,



USEPA, USFWS, the Erie County Department of Health (ECDH), and others confirmed the evaluation of impaired uses in the Bay. Sediment contamination and tumors in brown bullheads were the biggest concerns. Regarding pollutants of concern, work on both sediments and brown bullheads indicated that PAHs could be of greater concern than the heavy metals. The main source for the contaminants appeared to be the in-place sediments, as no correlation was found between water and sediment contaminant concentrations.

Additional studies were done to answer questions regarding the two potential beneficial use impairments identified in the 1993 RAP: (1) degradation of phytoplankton and zooplankton populations and (2) beach closings.

A seasonal study of the phytoplankton and zooplankton population of the Bay conducted by USEPA in 1992 and 1993 concluded that water samples collected from the Bay did not appear to adversely affect the population. On the basis of this information and analysis of conditions in the Bay, DEP concluded that the degradation of phytoplankton and zooplankton population beneficial use was not impaired (DEP, 1995a).

The 1993 RAP cited a limited impairment for the beach closing beneficial use at the mouth of the Mill Creek Tube and possibly at other creek and stormwater inputs to the Bay. Subsequent

sampling and analysis for bacterial contamination by DEP and personnel from the Presque Isle State Park over a six-week period in 1993 did not find bacteria in concentrations above the state's water quality standard for bathing beaches.


The ECDH has and continues to take monthly samples at the Water Quality Network station 632 located in the open Bay waters between the points where Cascade and Mill Creeks enter the Bay, directly in front of the public dock at Dobbins Landing. Bacterial concentrations have been consistently below the state's standard of 200 fecal coliforms per 100 milliliter.

While there are no designated bathing beaches in the Bay, there are no restrictions on its use for full body recreation based upon bacterial contamination. Based upon this information, the continued monitoring done by the ECDH, and the improvements to the City of Erie's combined sewer overflows, DEP concluded that no major impairment existed for water contact recreation in the Bay and therefore, the beach closing beneficial use was no longer considered impaired.

The remaining two beneficial use impairments identified in the 1993 RAP, (1) fish tumors and other deformities and (2) restrictions on dredging activities, were still of concern following the 1995 update and were the focus of additional studies described in this update.

PUBLIC INVOLVEMENT





Opportunities for public involvement are interwoven into the AOC remedial action process. Public involvement in the Presque Isle Bay RAP has almost exclusively consisted of meetings of the Public Advisory Committee (PAC). Growing out of the Erie Harbor Improvement Council, the PAC is composed of representatives from various AOC user interest groups, including local, state, and federal agencies; environmental and civic organizations; academia; and industry. The current members of the PAC are listed in Appendix A.

The role of the PAC is to create an opportunity for community involvement in the RAP process, so that consensus can be reached among competing interests, and to provide advice to DEP on RAP related activities. Since forming in 1991, the PAC has met three to eight times a year.

The PAC authored an educational brochure on the RAP in 1991, reviewed the 1993 RAP and the 1995 update, and participated in the public information meetings hosted by DEP. In

addition, the PAC has served as a peer review panel for the scientific studies being conducted on the Bay's sediments and fish populations. Over the years, the PAC has met many times to discuss investigation, remediation, and delisting of the AOC.

Members of the PAC and DEP have also participated in numerous education and outreach programs that explored the problems faced by the Bay and its watershed. One example is the Environmental Rediscoveries program sponsored by the Bayfront Center for Maritime Studies and Pennsylvania Sea Grant. Students investigate the health of the Bay on board the Friendship Sloop *Momentum*.

PAC members have also shared their expertise with local university students at Gannon University, Mercyhurst College, and Penn State's Erie campus. High school students attending the Regional Summer School of Excellence sponsored by Gannon University have had the opportunity to learn about Bay, its problems, and solutions from PAC members as well. Programs like these



provide the opportunity for PAC members to share the work they have done or sponsored and teach the next generation about the importance of preserving the Bay.

FISH TUMORS



According to IJC guidelines, the fish tumor and other deformities beneficial use impairment occurs when the incidence rates of fish tumors or other deformities exceed rates at unimpacted control sites or when survey data confirm the presence of neoplastic or preneoplastic liver tumors in bullheads or suckers (IJC, 1991). Brown bullheads (*Ameiurus nebulosus*) in particular have been widely used as biological indicators of environmental health in the Great Lakes region. This species is commonly affected with neoplasms (“tumors”, whether benign or malignant) of the mouth and skin. While most of these tumors are benign, some invade the dermis and are diagnosed as cancerous (Black, 1983). Both viral and chemical causes have been proposed for orocutaneous neoplasms (skin and mouth tumors) in brown bullheads (Black, 1983). Orocutaneous neoplasm rates are known to increase with specimen age, and may exceed 40 percent in older fish (MacCubbin and Ersing, 1991). Brown bullheads may also develop neoplasms of the liver. The cause of liver neoplasms is thought related primarily to exposure to chemical carcinogens in the environment

(Black, 1983). Therefore, the presence of liver tumors is thought to be a stronger indication of environmental contamination than is the presence of skin and mouth tumors. Polycyclic aromatic hydrocarbons are a leading class of known or suspected carcinogens thought to be responsible for chemically induced neoplasms in brown bullhead (e.g., Black, 1983; Baumann et al., 1982).



Tumored Brown Bullhead

Background

In 1984, the United States Fish and Wildlife Service (USFWS) field office in State College, Pennsylvania began receiving reports from anglers of “tumorous” growths on brown bullheads caught in Presque Isle Bay. In response to these reports, USFWS conducted a field survey of Bay brown bullheads later that same year. Forty-six brown bullheads were collected, necropsied, and visually examined by agency biologists for the presence of internal and external tumors and other deformities. The results of this study revealed the presence of *benign* tumors on the mouth and sides of “many” of the bullheads, but no liver tumors were found by gross observation.

In a more intensive follow-up survey in May 1985, USFWS collected and necropsied 93 brown bullheads for histopathological tumor analysis (microscopic examination of suspect tissue). This second, more definitive study documented an incidence rate of 11 percent oral neoplasms, 2.5 percent skin neoplasms, and 11 percent epidermal hyperplasms (non-tumorous proliferation of cells; reported in DEP, 1993).

Histopathological analysis, however, failed to detect liver neoplasia.

The DEP, in partnership with the Erie County Department of Health, conducted its first investigation of Presque Isle Bay brown bullheads in 1990. This survey consisted of gross visual observations of external “tumors” on 65 brown



Collecting bullheads using trapnets

bullheads collected from Pennsylvania Fish and Boat Commission (PFBC) trapnets set in the Bay. The external tumor rate was estimated to be an astonishing 86

percent based on this observational study. Subsequent to the listing of Presque Isle Bay as an Area of Concern, DEP became the lead agency for the investigation of the health of the brown bullhead population in the Bay. Major investigations conducted by DEP and/or its partners to date are summarized below. Readers are referred to the full reports for more information.

1991 DEP Study¹

As previously discussed, liver tumors are generally considered to be a much stronger indicator of environmental contamination than are



external tumors. Since prior studies failed to document the presence of liver tumors in Bay brown bullheads, DEP conducted a field survey on April 4, 1991 for the express purpose of obtaining liver tissue samples from the most heavily tumored (“worst case”) brown bullheads in Presque Isle Bay (cited in DEP, 1993). Ten livers and gallbladders from these “worst case” fish were sent to Dr. Eric May, a pathologist with the Maryland Department of Natural Resources. Dr. May identified neoplasms in 40 percent of these samples via histopathologic analysis. Dr. John Harshbarger of the Smithsonian Institute’s Registry of Tumors in Lower Animals, who failed to detect liver tumors during the mid-1980s fish surveys by USFWS, confirmed these results. This study was important in that it was the first to document liver neoplasia in Bay brown bullheads. In consideration of the purposive nature of this sample, however, these data should not be used to infer liver tumor rates for the Presque Isle Bay brown bullhead population at large. This work prompted a comprehensive investigation of the Bay brown bullhead population by DEP the following year.

1992 DEP Study

Subsequent to the discovery of liver tumors in Bay brown bullheads in 1991, DEP, in close cooperation with the PFBC and the Erie County Department of Health, initiated a comprehensive, multi-faceted study of the resident bullhead population beginning on March 29, 1992 (DEP, 1993). This study had two primary components: a mark-recapture component and a tumor-contaminant correlation component. The correlative component of the study included analysis of brown bullhead bile for several PAH metabolites and the histopathological analysis of various brown bullhead tissues and organs to confirm the presence of suspected tumors. Histopathology work was provided by Cornell Veterinary College (Jan Spitsbergen, DVM). Sediment samples were also collected for nitrosamine analysis—a class of naturally occurring organic compounds, which, like PAHs, also contain suspected carcinogens.

Over 3,100 brown bullheads were collected and 2,000 tagged for mark-recapture as part of this study. The mark-recapture study yielded a Bay brown bullhead population estimate of 31,715 individuals. This portion of the study revealed that while brown bullheads migrated extensively within Bay waters, these fish were residents of the Bay and did not typically enter

¹ Agency name was changed from Pennsylvania Department of Environmental Resources (DER) to Pennsylvania Department of Environmental Protection (DEP) on July 1, 1995. For consistency, DEP is used throughout this document

open lake waters. Therefore, any environmental stressors responsible for the brown bullhead tumors were thought to be present within the confines of the Bay. Sixty-one percent of the brown bullheads collected had external tumors based on gross visual observation. Recapture of tagged fish also revealed that tumors in the majority (92 percent) of individuals either progressed or remained the same over time. The minimal regression (i.e., healing) of fish tumors over time suggested that environmental contamination, not disease (e.g., viruses), was the likely cause for the tumors observed in the Bay brown bullheads. Other lines of evidence (e.g., observations of tumor progression in fish removed from the Bay, electron microscopy for viral particles, and inoculation of tumor-free fish with tumor homogenate) similarly suggested an environmental contaminant rather than viral causes.

Histopathology results of suspected skin tumors from a random subsample of 100 brown bullheads were in close agreement with visual observations, resulting in an incidence rate of 64 percent. Twenty-two percent of these fish were also found to have liver neoplasms. Bile analysis from a separate sub-sample of fish from various locations within the Bay revealed that tumored bullheads had significantly higher PAH

concentrations than tumor-free fish, suggesting that PAH metabolites may be playing a role in tumor formation. No fish from a separate “reference” population were examined, for comparison purposes.

Sediment analysis for nitrosamines in 1992 and 1993 suggested that this class of compounds might have been present in the Bay at levels capable of promoting fish tumors. Resampling of the same sites in 1994, however, found little or no nitrosamines in the Bay sediment. It is difficult to reconcile these conflicting nitrosamine data. Nitrosamine levels may have been elevated in 1992 and 1993 as a result of a record gizzard shad die-off in 1992. On the other hand, these data may have been spurious.



Gizzard Shad die off of 1992

1995 DEP Study

In the 1995 study, histopathological tumor analysis and bile PAH analysis were conducted on both brown bullheads and bowfin (*Amia calva*) (DEP, 1995b). Sixty-nine brown bullheads and 21 bowfin were collected from the Bay for necropsy. Ten additional brown bullheads were collected from Eaton Reservoir to serve as a reference population. Histopathological analysis was conducted by the Pennsylvania Department of Agriculture (Mark Walter, DVM and Donna Dambach, DVM).

In general, brown bullheads collected from the Bay appeared to be thin and in poor condition.

Thirty-eight percent of these fish had grossly observable external tumors. Histopathological analysis yielded a 28 percent external neoplasm rate and a 10 percent liver neoplasm rate for the Bay brown bullheads. By comparison, fish from the Eaton Reservoir reference population appeared to be in generally good condition and only one individual (10 percent) had a grossly observable external tumor. This suspected skin neoplasm was not, however, confirmed via histopathological analysis.



Electrofishing for Brown Bullheads

Two reference bullheads (20 percent incidence rate) also displayed liver neoplasia. Testicular carcinoma was also noted in a single brown bullhead in both the study (1 percent incidence rate) and reference (10 percent incidence rate) populations.

Contrary to the 1992 study, this study failed to find any meaningful relationship between bile PAH levels and neoplasm occurrence. In fact,

concentrations of the PAH metabolites naphthalene and benzo[a]pyrene in generally healthy brown bullheads from the reference lake were within ranges found in the Bay brown bullheads.

One noteworthy conclusion of this study was that nearly all hyperplasia and neoplasia occurred in very old fish. Additionally, brown bullheads in both reference and Bay populations appeared to be heavily parasitized.

1997 DEP Study

The 1997 study was similar in design to the 1995 study and consisted of histopathology

and bile analysis (DEP, 1997). A total of 75 brown bullhead and 19 yellow bullhead were collected for the study. Sixty-three *Ameiurus* sp. were collected from the Bay. Twenty-six combined bullhead species were also collected from Eaton Reservoir and five were collected from Lake LeBoeuf for reference purposes. The five fish from Lake LeBoeuf (ages 3-5 yrs.) were “discarded”, however, because high concentrations of PAH metabolites in their bile disqualified them as reference fish.

In general, bullheads from both study and reference populations appeared to be in good condition based on gross observation. A high level of parasitism, however, was again noted in virtually all of the fish. The overall liver neoplasm incidence rate (based on histopathology) for the Bay was 3.2 percent v. 3.9 percent for the reference (Eaton Reservoir)

population. The authors emphasized that these liver tumors are most likely due to the advanced age of the afflicted fish (15-16 years) and not to

environmental pollution. In fact, bile PAH concentrations of tumored fish were actually lower than the average concentrations in fish without tumors. Orocutaneous tumor rates were 11.1 percent for Bay fish but 0 percent for fish from Eaton Reservoir. These tumors were neither clearly associated with bile PAH concentration nor age of the specimen. It should be noted, however, that the contractor for this study (Penn State University’s Animal Diagnostic Laboratory) composited brown bullheads with yellow bullheads prior to analysis. Since yellow bullheads are known to have much lower liver and orocutaneous tumor rates than brown bullheads (e.g., DEP, 1993), this practice may have

confounded the study results by artificially lowering tumor rate estimates. The authors note that tumor rates in the 1997 study are lower than Baumann’s (1996) thresholds for indication of environmental degradation (i.e., 25 percent orocutaneous and 5 percent liver). As was the case during 1995, specimen age was found

to be positively related to tumor incidence rates, but bile PAH metabolite levels were not. This study also provides a useful comparison with the



**Extracting liver
from Brown Bullhead**

1992 and 1995 bullhead studies, noting a clear trend in decreasing bullhead tumor incidence rates. Tumor rates were found to be highest in 1992, intermediate in 1995, and lowest in 1997. It is also very noteworthy, though unexplained, that average brown bullhead age followed the same trend.

1999 Pyron et.al Study

Pyron et al. (2001), in follow-up to past DEP studies, examined both gross and histopathological external tumor rates as well as liver tumor rates. A population estimate was also provided from a mark-recapture study. The grossly observable external tumor rate was estimated to be 19 percent. A random sample of 23 brown bullheads were necropsied for histopathological analysis. No liver neoplasms were found (0 percent incidence rate) but four (17.4 percent) had orocutaneous neoplasms. Larger (presumably older) individuals were significantly more likely to have tumors.

The population estimate of 30,950 was very similar to the 1992 estimate (31,715), suggesting that the Presque Isle Bay brown bullhead population is stable. Significantly fewer brown bullheads were recaptured during this study than the 1992 study. Three Young-of-Year brown bullhead were also collected via seining, providing

further evidence that at least some level of reproduction is occurring.



Seining for Brown Bullhead

Discussion

The tumor rates documented in the Bay brown bullheads in the early 1990s are striking, and it is not surprising that this beneficial use of Bay waters was determined to be impaired. After 10 years of intensive study, however, the cause of these tumors remains unclear. There is strong scientific evidence that at least some (but by no means all) of the neoplasms reported in Great Lakes fishes are caused by environmental carcinogens (e.g., Hayes et al., 1990; Metcalfe et al., 1998; Baumann et al., 1991). Accordingly, the leading classes of environmental carcinogens suspected of inducing tumors in brown bullhead have been investigated by DEP, its contractors, and others in the studies described above. The

Table 2. Temporal trends in tumor incidence rates in brown bullhead (*Ameiurus nebulosus*) in Presque Isle Bay, Pennsylvania. N/A means not investigated during study.

Study Date	Orocutaneous tumor rate- gross observation [Rate (# with tumors/total sample)]	Orocutaneous tumor rate- histopathology [Rate (# with tumors/total sample)]	Liver tumor rate- histopathology [Rate (# with tumors/total sample)]
1985	39 % (36/93)	13% (12/93)	0 % (0/93)
1990	86 % (56/65)	N/A	N/A
1991	N/A	N/A	40% (4/10)
1992	61 % (1922/3151)	64 % (64/100)	22 % (22/100)
1995	38 % (26/69)	28 % (19/69)	10 % (7/69)
1997	N/A	11.1 % (7/63)	3 % (2/63)
1999	19% (177/930)	17.4 % (4/23)	0 % (0/23)

primary conclusion of this research has been that there is little correlation between levels of the environmental contaminants investigated and tumor rates in brown bullheads in the Bay. In fact, with the exception of the 1992

study, there has been virtually no correlation between bile PAH concentrations (the leading class of compounds implicated in brown bullhead carcinogenesis) and neoplasm rates in the subject fish. Another significant conclusion of this work is that brown bullhead tumors, whatever their ultimate causes, are positively related to the age of the specimen (i.e., older bullheads are more likely to have tumors than are younger bullheads). Yet another consistent observation across studies is that bullheads from both the Bay and reference

lakes appear to have a high parasite burden in internal organs, including the liver. This heavy parasite burden may play a causative role in tumor formation through direct damage of the host tissue.

...studies taken together show a clear trend of decreasing tumors in the fish since 1990.

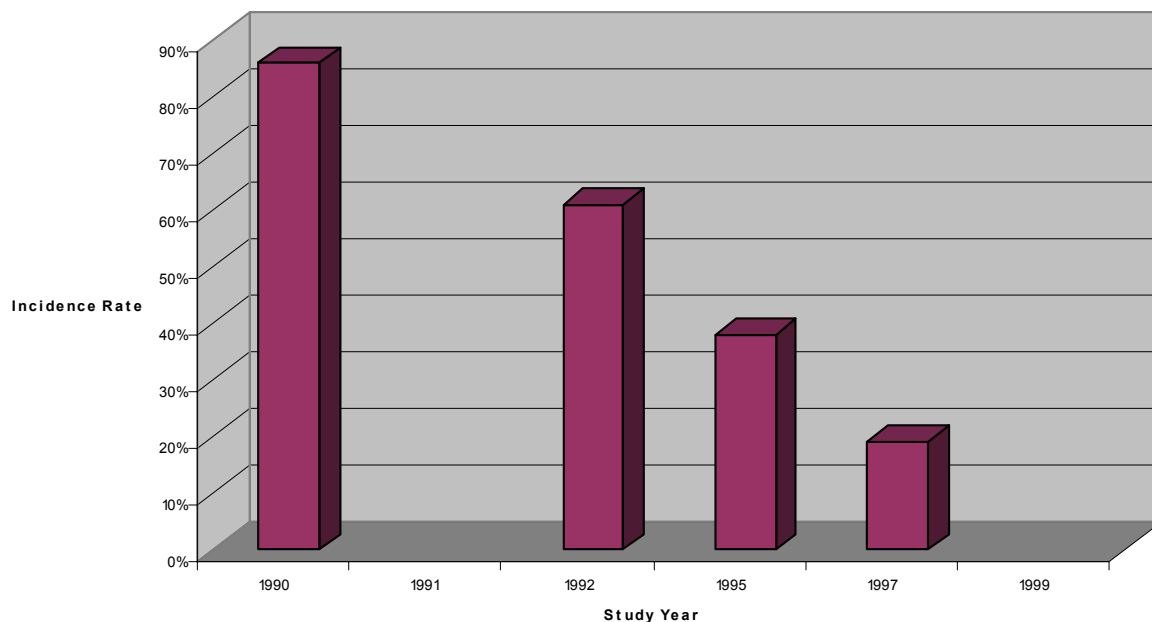
While the causes of the Bay bullhead tumors remain unknown, these studies taken together show a clear trend of decreasing tumors in the fish since 1990 (Table 2, Figures 4-6). Grossly observable external tumor incidence rates progressively declined from a high of 86 percent in 1990 to a low of 19 percent in 1999. These observations are in good agreement with histopathological analyses of external neoplasms, which also progressively decreased over time from a high of 64 percent in 1992 (no histopathology

work was conducted in 1990) to a low of 17.4 percent in 1999. As previously discussed, liver tumors in fish are thought to be causally related to environmental carcinogens and are therefore generally considered to be more robust indicators of environmental contamination than are orocutaneous tumor rates. Liver tumor rates have mirrored orocutaneous tumor rates (excluding 1991 “worst case” data), progressively decreasing from 22 percent in 1992 to 0 percent in 1999. Moreover, liver tumor incidence rates in Bay brown bullheads were comparable to or below liver tumor rates found in brown bullheads from non-polluted “reference” lakes. For example, liver neoplasm incidence rates were 10 percent in Bay

bullheads v. 20 percent in reference bullheads in 1992 and 3 percent in Bay bullheads v. 4 percent in reference bullheads in 1997.

While these trends are encouraging, their interpretation is confounded by the fact that the mean age of the Bay bullhead sample has also decreased over time. Since tumor incidence rates are positively related to specimen age, the decreasing tumor incidence rates described above may simply be an artifact of the decreasing mean sample ages rather than a reflection of improving environmental conditions in the Bay. Similarly, sample sizes (though not always sampling effort) have varied widely among study sites and study years (Table 2). Therefore, this and related forms

Figure 4: Temporal trends in orocutaneous tumor incidence rates (based on gross observation) in brown bullhead (*Ameiurus nebulosus*) in Presque Isle Bay, Pennsylvania





of sampling bias could also account for the results described above.

Nonetheless, Pyron et al. (2001) concluded that the overall health of the brown bullhead population in Presque Isle Bay has improved dramatically since 1992. Skin and liver tumor rates have decreased to background levels, the population is reproducing, and the population estimate is stable. The authors suggest that the trend in decreasing tumors may be related to the elimination of various sources of pollution in the Bay's watershed, including the coal-fired power plant, combined sewer overflows, and dry weather sewage discharges from the Erie sewage treatment plant.

The improved health of the Bay brown bullhead population over time suggests that these fish are in a state of recovery. Baumann et al. (1996) suggested that orocutaneous tumor incidence rates of greater than approximately 25 percent or liver tumor rates greater than approximately five percent are indicative of environmental degradation. Bay brown bullhead tumor rates have been below this level since 1997. Baumann (personal communication) later stated that his previously published contamination thresholds were too high, and that a 15 percent orocutaneous rate and five percent liver tumor rate (both as determined by histopathology) were

more appropriate impairment standards. Even using these more conservative standards, the Presque Isle Bay brown bullheads appear to be at or below Baumann's tumor incidence rate thresholds. Moreover, liver tumor rates in Bay fish appear to be comparable to those from unpolluted inland reference lakes, although orocutaneous tumor rates are still somewhat higher (e.g., DEP, 1997). These facts strongly suggest that the fish tumor and other deformity beneficial use impairment in the Presque Isle Bay AOC should be considered to be in a Recovery Stage. Long-term monitoring of both the Bay and reference lake brown bullhead populations will be necessary, however, to establish the temporal stability of this trend of decreasing tumors in Bay brown bullheads and to clarify the relationship between mean sample ages and tumor incidence rates discussed above. The framework for a long-term brown bullhead-monitoring plan for Presque Isle Bay is attached as Appendix B.

Figure 5. Temporal trends in orocutaneous tumor incidence rates (based on histopathology) in brown bullhead (*Ameiurus nebulosus*) in Presque Isle Bay, Pennsylvania.

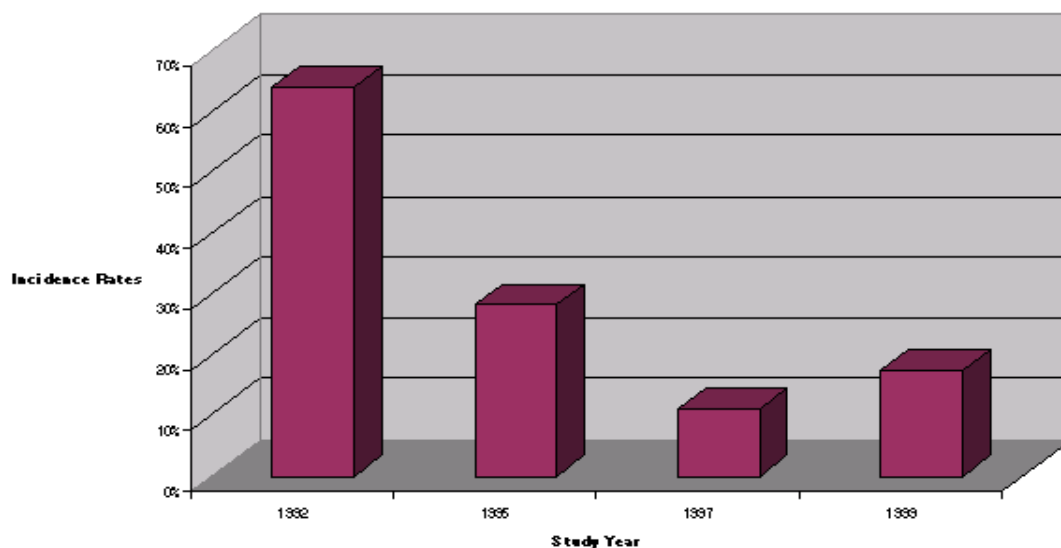
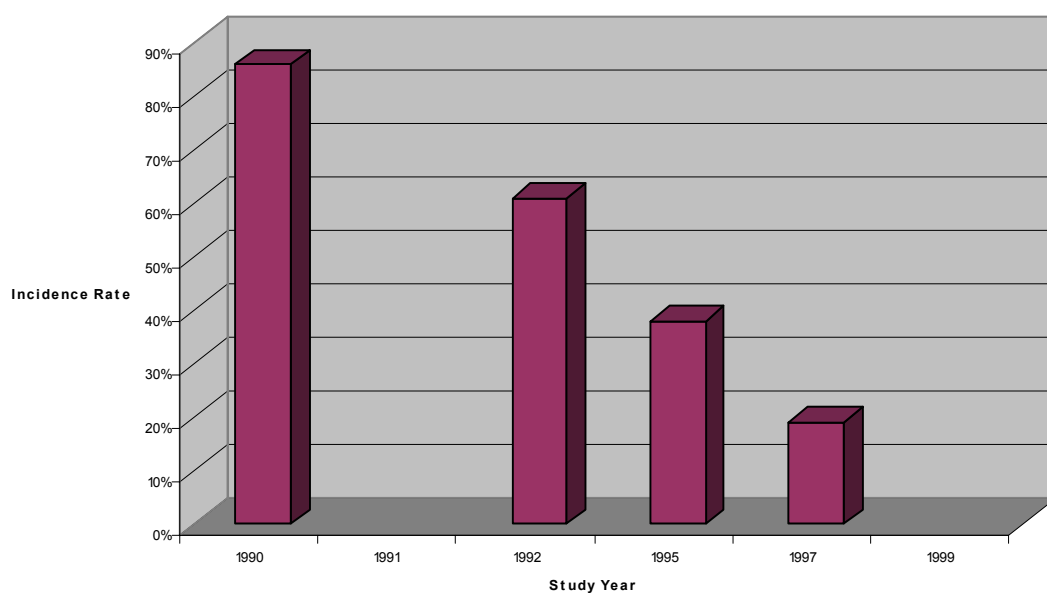



Figure 6. Temporal trends in liver tumor incidence rates (based on histopathology) in brown bullhead (*Ameiurus nebulosus*) in Presque Isle Bay, Pennsylvania.





SEDIMENTS



The IJC guidelines define the beneficial use impairment for restrictions on dredging activities when contaminants in sediments exceed standards, criteria, or guidelines such that there are restrictions on dredging or disposal activities (IJC, 1991). The 1993 RAP concluded that the levels of sediment contamination in the Bay resulted in an impairment for this use. Both the IJC and USEPA concurred with the RAP's finding. That finding was based on historic data that was compared to the USEPA's *Guidelines for the Pollutational Classification of Great Lakes Harbor Sediments* (USEPA, 1977).

The criteria established by the IJC for this impairment, and the USEPA guidelines noted above, were designed specifically to address the suitability of dredged sediments for open lake, confined, or other disposal. However, as pointed out in the 1995 RAP update, the scientific community has questioned the validity of the 1977 USEPA guidelines, and they have essentially been abandoned in favor of more modern criteria. The discussion contained in the original RAP

document, while valuable for historic background, does not reflect changes in methods and evaluative criteria, and has been superseded by the 1995 RAP update. The 1995 RAP update also concluded that there is a lack of scientific consensus on sediment quality criteria against which sediment data could be compared to determine the severity of contamination. More recent sediment quality criteria have been used for comparison purposes by some of the sediment studies discussed later in this section.

In light of the conclusion that the 1977 USEPA Guidelines are not directly applicable to evaluation of Bay sediments, much of the discussion regarding the restrictions on dredging activity has focused on the potential need for dredging from a remediation and economic standpoint. There have been numerous studies by DEP and others to evaluate the need for remediation due to unacceptable environmental impacts from sediment contamination along with an evaluation of the potential for dredging due to economic factors.

Background

The history of sediment studies in the Bay is extensive. Figure 7 provides a brief summary of the studies that formed the basis for the conclusions reached in the 1993 RAP, the 1995 update, and this document. Readers are referred to the full reports for more information. The focus of this update is on studies that have occurred since the 1993 RAP. Particular emphasis is placed on data trends and conclusions developed after the 1995 RAP update.

1997 Battelle Study

This comprehensive review included a thorough evaluation of previous data collected by USEPA, DEP and others. In May 1994, USEPA took grab samples of sediment from 21 stations throughout the Bay for bulk chemistry analysis; 12 stations for toxicity testing; and eight stations for macroinvertebrate community analysis. Additionally, the zooplankton community was sampled at four stations and 12 discrete whole-water samples (i.e., four stations at three depths each) were collected for phytoplankton inventory.

Simultaneously, sediment core samples were collected at the same locations for lead-210 dating. Polycyclic aromatic hydrocarbons analyses were performed on cores from 20 of the 21 stations and the lead-210 dating was conducted on eight cores (Battelle, 1997). The 1997 Battelle data review was undertaken in an attempt to answer several questions related to Bay sediments, including chemical characteristics (particularly PAHs), sediment deposition rates, and potential remediation options based upon the data collected previously. No new data were obtained for this study. This summary of the 1997 Battelle data review focuses on the data analysis and conclusions that are related to the sediments. It does not include a discussion of the

conclusions drawn regarding tumors in brown bullheads.

PAHs are the primary contaminant of concern for Bay sediments and Battelle's review of the data revealed that all sediment sampling

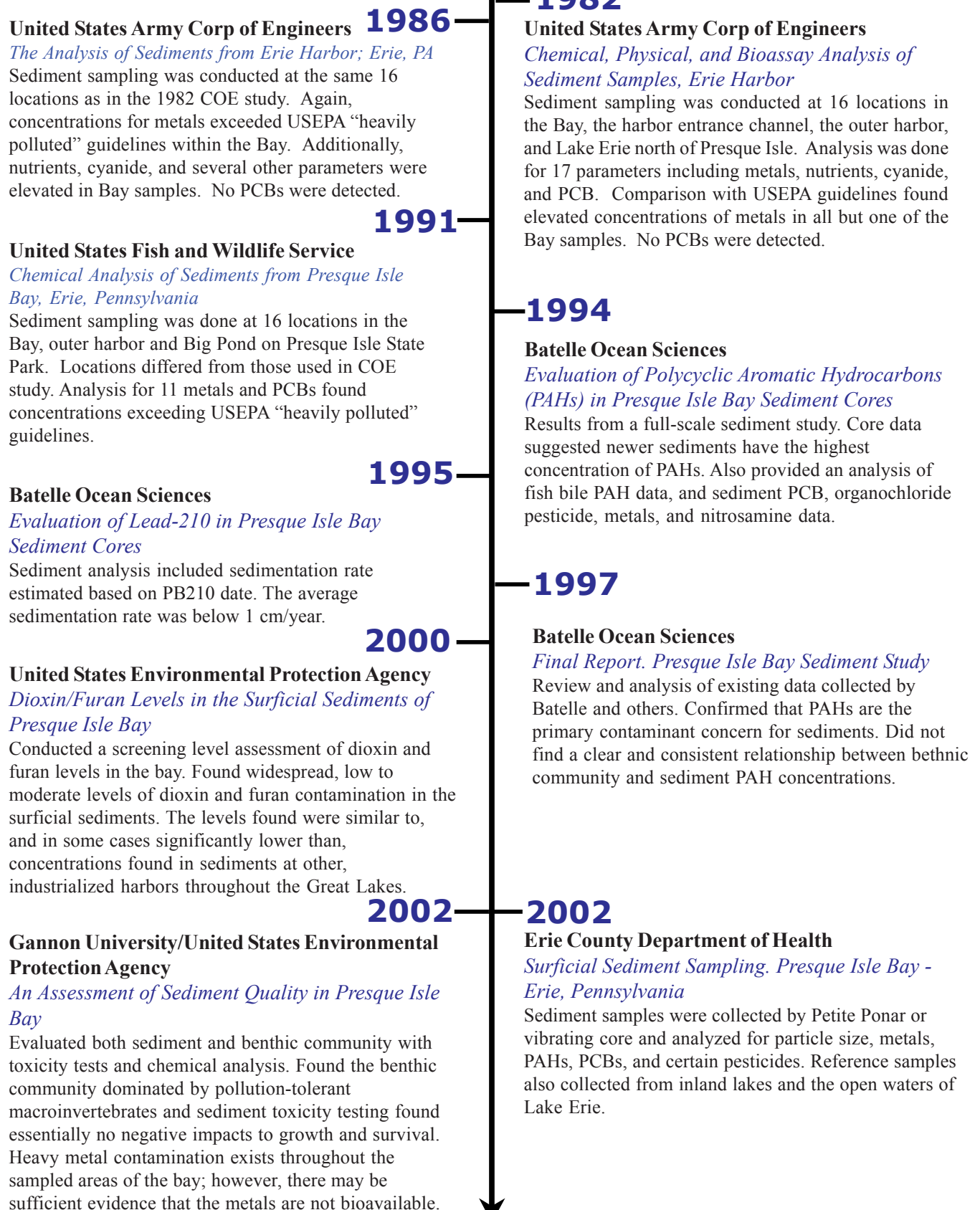
locations contained elevated levels of PAHs. The data also showed that PAH concentrations in the Bay surface sediment were higher than in sediment from most coastal



Sediment sampling conducted by USEPA's Mudpuppy



Figure 7. Summary of Presque Isle Bay Sediment Studies





environments, including those of the Great Lakes. The concentrations, however, are not surprisingly or uncommonly high, concluded Battelle, considering the urban nature of the area, and the physical characteristics of the Bay. In general terms, PAH contamination in the Bay results from pyrogenic sources and is highest in the surface sediments. Contamination is highest on the City side of the Bay, particularly in areas adjacent to Cascade Creek, Mill Creek, and the public docks. It was also concluded that PAH concentrations in sediments within the Bay were higher than outside the Bay. This indicates that sources of PAHs to the Bay are not naturally occurring.

The study did not find a clear and consistent relationship between sediment concentrations of PAHs and benthic community impairments. Data suggests that PAHs in the sediments have had an impact on local benthic fauna; as such communities were altered slightly in a few locations where concentrations of sediment PAHs were high. However, the sediments containing the highest concentrations of PAHs also contained the highest concentrations of clay, leading to the conclusion that the benthic communities may have been affected more by poor habitat conditions related to low sediment grain size than by high concentrations of PAHs. Additionally, the PAHs in the sediments were

thought to be tightly bound to sediment, organic matter, and inert particles, which would make them only slightly bioavailable to benthic fauna.

Several other contaminants were measured in the Bay sediments. Freshwater sediment “Lowest Effects Levels” (LEL)² were exceeded for PAH and arsenic in the Bay sediment samples. The severity of impacts expected from these high concentrations of PAHs were not observed in the benthic community analysis, which may be due to the pyrogenic nature of the PAHs. (Note: The 4.0 mg/kg LEL used in this study is much lower than the sediment quality criteria of 22.8 mg/kg used in the 2002 Gannon study.) While arsenic was found in some sediments at concentrations high enough that it could be toxic to benthic organisms, lack of information on the chemical form and bioavailability of arsenic make this an uncertain conclusion.

In laboratory experiments comparing effects of sediment on amphipod survival, sediments from four stations caused mortality among the amphipod *Hyalella azteca* at a higher level than with controls. However, there was no correlation to the sediment PAH or arsenic concentrations established. The only significant correlation observed was between

² Lowest Effects Level (LEL) is the concentration of contaminant at the low end of the range in which effects in the sediment dwelling community might be observed (Battelle, 1994).



Sediment sampling using ponar dredge

sediment toxicity and total organic carbon (TOC) levels in sediments. Previous studies have shown that the bioavailability of PAHs in sediments decreases with the length of time of contamination. TOC and percent clay appear to play the largest role in the structure of the altered benthic community and toxicity of the Bay sediments.

Sediment core data subjected to the lead-210 dating technique revealed an average sedimentation rate of just below 1 cm/yr. Although the data set was small (n=4) and indicated a variable rate across the area sampled, this rate can be used as a tool to determine approximate dates of sediments at depth as well as estimate approximate rates for a natural recovery remediation option. This sedimentation rate is a generalization that is certainly not accurate for all parts of the Bay. There are many factors that influence sedimentation rates, and future studies on sediment transport and deposition to the Bay may help draw more accurate conclusions.

2002 Gannon University Study

In July 2002, Gannon University completed “*An Assessment of Sediment Quality in Presque Isle Bay*” under contract with the USEPA’s Great Lakes National Program Office. The study is based upon data collected in 2000. The purpose of the study was to determine if contamination levels within the Bay sediments present a significant human or ecological health risk. The study used a “triad” approach which subjects concurrently collected sediment samples to benthic community surveys, toxicity tests, and chemical analysis in an effort to gain insight into the overall potential for negative ecological and human health effects from exposure to the sediments.

The ten sites selected for the study included six locations along the City side of the Bay, two sites along the centerline of the Bay, and two locations along the shore near Presque Isle State Park. Sediment samples were analyzed for benthic macroinvertebrate community structure and subjected to whole sediment toxicity tests on three macroinvertebrate species and chemical analysis for particle size distribution, TOC, oil and grease, PAH, and five metals (cadmium, copper, nickel, lead, and zinc). This study generally reinforced some of the findings from the 1997 Battelle data review in terms of sediment particle size and effect of the sediments on the benthic community.



The benthic community is dominated by pollution-tolerant macroinvertebrate species such as oligochaetes (segmented worms) and chironomids (midges) along with moderately tolerant gastropods and amphipods. Pollution-sensitive organisms, such as mayflies and caddisflies, were absent or rare in Bay sediments.

Sediment toxicity testing was conducted on three organisms, *Chironomus tentans*, *Daphnia magna*, and *Hyallela azteca*. No negative impacts to growth and survival were observed on the *C. tentans* and *H. azteca*. These organisms are considered to be relatively pollution-tolerant. However, *D. magna*, which is considered to be a pollution-sensitive organism, demonstrated reduced reproductive success when exposed to Bay sediments. The number of offspring was significantly lower when compared to the control sample. The number of offspring in the control sample was 40 – 45, while the organisms exposed to Bay sediments had a range of 10 – 30 offspring.

The study found heavy metal contamination throughout the sampled areas of the Bay. In the absence of universally accepted sediment quality criteria, metals data were compared to LELs, Severe Effects Levels (SEL)³, and Probable Effects Concentrations (PEC)⁴ as a way to gauge the potential for the levels detected to result in negative

ecological effects. In general, total metals concentrations were above the LEL in almost all cases, regardless of the metal or the depth of the sample. Nickel, lead, and zinc exceeded the SEL and PEC at most locations and depths. Cadmium exceeded the PEC but not the SEL in most samples while copper was lower than both the SEL and PEC in most samples. An attempt to reveal the bioavailability of these metals showed that, while the metals were present at all locations, there may be sufficient evidence to indicate that those metals are not bioavailable.

In addition, total PAH concentrations for 16 “priority” PAHs were compared to a PEC of 22.8 mg/kg. Approximately 30 percent of the samples analyzed exceeded the PEC at seven of the ten locations. Surface samples were more likely to exceed PECs than the bottom layer samples, a pattern consistent with earlier studies.

³ Severe Effects Level (SEL) is the level of sediment contamination that can result in a pronounced disturbance of the sediment dwelling community (Ingersoll, 2000).

⁴ Probable Effects Concentration (PEC) is the level of chemical concentration above which adverse effects in sediments are expected to occur frequently (Ingersoll, 2000).



2002 Erie County Dept. of Health Study

The Erie County Department of Health with assistance from USEPA, Gannon University, Pennsylvania Sea Grant, and DEP, conducted additional research on sediment quality in the Bay in 2000. Core and dredge samples were taken at nine sites in the Bay. Control samples were collected in Lake Erie (several miles east of the City), Lake Pleasant, and the Union City Reservoir. The samples were analyzed for heavy metals (arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc), P A H s , polychlorinated biphenyls (PCBs), and certain pesticides.

...changes taking place in the streams feeding into the Bay have greatly improved water quality.

Metals were detected at levels equaling or exceeding at least one PEC at seven of the nine Bay stations. PCBs were also found in six out of eight sediment samples at concentrations above the Threshold Effects Concentration (TEC)⁵. PAH and pesticide data were not discussed in the report. The report recommends some additional areas for research and sampling, but emphasized that changes taking place in the streams feeding into the Bay have greatly improved water quality. It goes further to imply that active remediation of

the sediments is not warranted as long as the reduction and/or elimination of pollution to the Bay continue.

⁵ Threshold Effects Concentration (TEC) is the level of sediment contamination below which adverse effects to the sediment dwelling community are not expected to occur (Ingersoll, 2000).

Genetic and Dioxin Testing

In 1999 DEP contracted Penn State's Department of Veterinary Science and Molecular Toxicology Program to perform a genetic study to examine a possible connection between PAHs and the incidence of tumors in the brown bullhead of Presque Isle Bay (Vanden Heuval, 1999). Samples of sediments from the Bay and Cascade Creek along with brown bullhead liver tissue samples from the Bay and

Eaton Reservoir were shipped to Penn State for genetic analyses. The results showed that various portions of the Bay's sediments, in particular the Cascade Creek area, have significant concentrations of PAHs and dioxin "toxic equivalents" that could be bioavailable for tumor promotion.

The data indicated that sediment in the Bay contained significant levels of contaminants, including PAHs and dioxins that can potentially trigger genetic response. The study concluded,



however, that the brown bullhead population has either adapted to their environment or are nonresponsive to these carcinogenic compounds present in the sediments.

Results from the genetic studies led to concerns of some PAC members that dioxin and furan concentrations in sediments, which to this point had not been researched, could be a significant human health issue. As a result of those concerns, sediment sampling for dioxin and furans was performed in June 2000 (GLNPO, 2001). Due to the lack of Pennsylvania or Great Lakes-wide screening criteria, dioxin/furan sediment concentrations were compared to screening levels from New York State. That screening showed that all sampling locations exceeded the “background” screening level, but fell well below the “heavily contaminated” screening level. Further, all results were below human health screening levels by a factor of five to 20. However, since all locations exceeded the wildlife screening criteria based on potential reproductive effects in fish-eating mammals, another phase of sampling was performed. During this phase, fish tissue was analyzed to determine the potential for bioaccumulation of dioxins and furans (DEP, 2001). When concentrations from the tissue of six species were compared to advisory level criteria for human consumption, concentrations

were below threshold advisory levels by a factor of seven to 600.

Additional Factors

In addition to the environmental factors considered for potential dredging scenarios, other factors must also be taken into consideration. First is the economic consideration of whether or not there will be routine dredging performed to maintain the inner harbor and navigation channel by the United States Army Corps of Engineers, Buffalo District. The Corps bases its decision to dredge on an economic evaluation that seeks to determine if the economic benefits to the community, in terms of commerce and recreation, outweigh the cost of dredging. Based on cost-benefit analyses, the Corps has determined that there is no current or immediate-future need for dredging. This conclusion is based on the fact that the shipping channel is not filling in with sediment as fast as expected by the Corps.

Another significant consideration has to do with the remedial measures undertaken in the recent past to eliminate point source discharges to the Bay. It is assumed that these remedial measures are resulting in generally lower contamination loadings today as compared to when the Bay was first designated an AOC. Reduced chemical loading to the Bay, which should be confirmed through sedimentation



studies and continued monitoring, will aid in the natural recovery of the Bay and make dredging for environmental purposes even less likely. Further discussion of the details of the remedial efforts to reduce potentially toxic loading to the Bay is in the Ongoing Activities section of this report.

Discussion

It is generally accepted by those who evaluate the volumes of data collected for sediments that there is indeed widespread contamination within the sediments of the Bay. Numerous studies reveal low to moderate levels of contamination from metals and organics, most notably PAHs. These studies have attempted to identify hotspots that might require localized dredging. They have also attempted to identify potential toxicity and bioaccumulation concerns, which also could lead to localized or even widespread dredging. Study after study, however, failed to lead the PAC and DEP to the consensus that dredging is a necessity for the future health of the Bay.

With the conclusion of each study, whether it is to identify hotspots, connect a class of chemicals with a specific ecological effect, or investigate a theory on an emerging chemical of concern, additional questions are raised instead of absolute conclusions. The studies have shown,

however, that there are apparently no acute or discrete contamination problems in the Bay that dictate an immediate decision to dredge.

The lack of absolute conclusions from years of study, the success achieved in eliminating point source discharges and combined sewer overflows from the Erie wastewater treatment plant, and the Corps' cost benefit analyses indicate that there is no significant economic reason to dredge within the foreseeable future, point to the same conclusion: attention and resources should be re-focused toward a watershed approach that stresses pollution prevention. Instead of continuing to study the Bay sediments for remediation purposes, it is apparent that there is more to gain in terms of health of the Bay's ecosystem by directing future efforts to research on sedimentation and nonpoint source issues within the watershed.

...the beneficial use impairment for restrictions on dredging is recovering.

Studies done by Battelle (1997), Gannon University (2002), and the Erie County Department of Health (2002) support this conclusion by suggesting that it may be beneficial to shift focus from evaluating historic contaminant levels in the Bay toward an approach that stresses




improving the quality of sediment transport and loading from the watershed to the Bay. Natural recovery in the Bay will occur over time if new sediments entering the Bay are less contaminated than those present. Therefore, efforts to reduce the levels of contamination that continue to be discharged to the Bay through nonpoint sources will ultimately be more productive than continuing to expand on the two-decade history of sediment studies in the Bay.

It is this rationale that has led to the recommendation that the beneficial use impairment for restrictions on dredging is recovering. That should not be interpreted to mean that there is no potential for future remediation needs, should data collected through ongoing monitoring indicate unacceptable human health or ecological threats. On the contrary, continued, diligent monitoring of Bay sediments is essential in order to track the progress of natural recovery and observe ecological indicators. The framework for long-term sediment monitoring plan for Presque Isle Bay is attached as Appendix C.



ONGOING ACTIVITIES



While the historical industrial uses and disposal of sewage and other wastes have degraded the resources of the Bay, a lot of cleanup and other work has been done to address the pollutant loading resulting from these practices. Much of the work has been accomplished as a result of the efforts of DEP's partners, local environmental, education, and civic organizations, changes in infrastructure, and shifts in Erie's economic base. For example, upgrades and improvements to the City of Erie's sewage treatment plant and collection and conveyance system are directly linked to the improved health of the Bay. Additionally, changes in the Bay's landscape from industrial to enhanced recreation opportunities have resulted in the reduction of contaminants found in stormwater runoff and storm sewer discharges entering the Bay.

These changes have also reduced the number of discharges to the Bay. In fact, there are currently only eight discharges to the Bay and its tributaries permitted under the National Permit Discharge Elimination System for industrial

wastewater. Six of the eight discharges are non-contact cooling water and the other two are filter backwash from Erie's drinking water plant that now have been diverted to the Erie wastewater treatment plant through the City's conveyance system. In addition, only two facilities discharge domestic wastewater into the Bay and both are permitted under NPDES.

A great deal of the work done to assess and remediate the Bay and its watershed is conducted, coordinated, and sponsored by the DEP. The USEPA, the Erie County Department of Health, and organizations and individuals participating on the PAC join the DEP in this effort. Monitoring air quality and providing funding for watershed assessment and cleanup work are just two examples of the activities that are improving conditions in the Bay.

Additionally, many levels of government, nonprofit and private organizations, watershed associations, and academic institutions have been and are continuing to do work in the Lake Erie Watershed, these partnerships are having a positive



and profound effect on the environmental health of the Bay.

Stream cleanups, education campaigns, water sampling, and streambank erosion controls are just some of the projects taken on by these groups.

Many of the activities undertaken or ongoing in the Bay and its watershed have not necessarily been started to address the beneficial use impairments identified for the AOC. They have, however, provided significant benefits. This section summarizes the work of some of DEP's partners and other programs that are improving and changing the landscape of the Bay and its watershed, the financial assistance provided by state and federal programs, and monitoring and related studies focused on improving the condition of the Bay and its watershed.

Partners and Other Programs

The rejuvenation of Erie's waterfront and improvements in the health of the Bay and its watershed would not be possible without the many local partnerships working together towards the same goal. Using various funding sources, volunteer resources, and their combined expertise, knowledge, and experiences, these partners have improved their own practices, undertaken projects to assess, clean up and preserve the Bay, and

educated those living in the watershed about this valuable resource in need of care. Some examples of these partners and their work are provided below.

City of Erie/Erie Sewer Authority

The first sewage collection facilities for the City of Erie were constructed in 1911. Raw sewage, however, continued to discharge into the Bay and Lake Erie. The first primary treatment plant was built in the 1930s, secondary treatment in 1954, and expansions and upgrades followed in the 1970s, 1980s, and 1990s. In spite of these improvements, problems remained and discharges from combined sewer overflows and the treatment plant into both the Bay and Lake Erie continued.

The majority of the watershed is sewered, and served by the City's wastewater treatment plant, which discharges to the outer harbor. In addition to the City itself, Erie's collection and conveyance system also receives sewage from the surrounding metropolitan areas, including six municipalities.

In 1989, the City of Erie and the Erie Sewer Authority entered into a Consent Order with DEP to address problems with Erie's conveyance system. The City and the Authority had already initiated several projects that would result in improvements to the Bay such as increased treatment of the incinerator exhaust and

an Outfall Relief Study. The Consent Order required Erie to address the water filtration plants backwash and to determine the extent of pollutants discharged from the collection system, storm system, and treatment plant into Mill Creek, the Bay, and Lake Erie, and to evaluate both structural and nonstructural alternatives to reduce these pollutants.



**Erie's Wastewater treatment plant
and the Millcreek Tube**

With the completion of all major construction defined by Erie's updated Act 537 Plan completed in response to the original Consent Order, the City has met all the terms of the order and it now has been terminated. The City has spent \$93 million on projects intended to improve Bay water quality including studies, sewer rehabilitation and separation, wastewater treatment plant expansion, conveyance capacity increases, combined sewer overflow abatement, and supplemental construction activities to protect the integrity of completed construction. Work that has been completed to date includes the following:

- Reduction of the number of permitted and non-permitted combined sewer overflows from more than 70 to five.
- Elimination of inadequately treated sewage discharges into the Bay and Lake Erie by:
 - (1) preventing known unpermitted dry weather discharges and formulating alternatives for wet weather discharges into Mill Creek; a tributary of the Bay tubed through the center of the City;
 - (2) formulating alternatives for removal of sources of pollution outside of the Mill Creek Basin entering the Bay and Lake Erie and their tributaries;
 - (3) completing an update of the City's Official Sewage Plan which included a schedule for implementing the plan (as treatment or conveyance needs were identified and DEP's concurrence obtained, the City voluntarily added those to the Consent Order schedule).
- Construction of improvements to the wastewater treatment and conveyance systems to remove as much sewage-contaminated water from the Bay as possible by removing extraneous flows from the sewer system and by transporting as much of the remaining



combined sewer overflow as possible to the wastewater treatment plant for treatment and discharge to the Lake Erie.

Construction improvements completed to date

- 1) construction of an overflow retention facility to expand treatment capacity to handle anticipated peak flows from wet weather events;
- 2) construction of a deep-water outfall relief;
- 3) upgrades to screens and grit chambers;
- 4) construction of various interceptor relief sewers for the trunk sewers on both the east and west side of Erie;
- 5) upsizing of sewers outside the center City area (i.e., Mill Creek Drainage basin);
- 6) numerous sewer system rehabilitation and separation projects in an effort to reduce the number and amount of overflows and to reduce the extraneous flows reaching the wastewater treatment plant (there have been 18 sewer separation projects and more than six sewer rehabilitation projects); and
- 7) construction of relief interceptors (tributary to the wastewater treatment plant) to either carry diverted flows from existing sewers to allow for more capacity to handle combined sewer overflows or to provide capacity directly for combined sewer overflows and/or future growth flows.

With the completion of this construction, up to 50 million gallons per day of combined sewer overflow volumes previously discharged to the Bay and its tributaries during extreme wet weather will have been diverted to the wastewater treatment plant.

As part of the City's initial efforts to identify sources of pollution, the "Mill Creek Tube Study" allowed for the identification and

abatement of several direct connections and dry-weather overflows during what was termed the "Dry-Weather Mitigation Program". Six major direct sanitary sewer connections, an overflow connection, and a leaking sanitary sewer were eliminated from 1994 to 1996.

Another early effort, the "Other Sources of Pollution Study", monitored water quality at the stream and storm water outlets to the Bay

and Lake Erie other than the Mill Creek Tube. The City's sampling program identified the pollutants entering the Bay and Lake Erie and determined that sanitary sewage was the major source. A program was then initiated to locate the sources and reduce or eliminate the pollutants. The City addressed the following: the elimination of several direct sanitary sewer connections to storm sewers and seven combined sewer/storm sewer overflows; a sewer rehabilitation project; and one sewer relocation project. Issues with private entities (i.e., non-sanitary) were referred to DEP for resolution. Erie continues to monitor the stream and storm sewer outlets on a quarterly basis for domestic sewage pollution parameters.

The Combined Sewer Overflow Long-Term Control Plan commits the City to a schedule of studies and construction which will: evaluate the success of the present effort, make recommendations for future improvements, and complete construction projects intended to maintain (1) the integrity of the present facilities; and (2) the intended degree of treatment.

In a recently completed Five-Year Capital Improvement Plan, the

City and Authority project \$22 million in additional construction cost needs to maintain plant facilities, upgrade and optimize its operational and treatment capabilities, and complete any sewer upgrades necessary under the Long-Term Control Plan. In the meantime the wastewater treatment plant's effluent continues to be well within the limits of its NPDES Permit monthly requirements. The effluent quality's annual average has been less than 20 mg/l suspended solids; 15 mg/l biochemical oxygen demand (BOD); and 0.9 mg/l phosphorus for the last four years. During that same time frame there have been no exceptions to the bacteriological limitations used to protect water contact sports.

Erie County Conservation District

The Erie County Conservation District (ECCD) is integrally involved with and leads a number

of activities in the Lake Erie Watershed that positively impact the Bay and the streams feeding it. In addition to assisting in the formation of watershed groups and advising



ECCD's Headwaters Park

them on issues such as how to address complex restoration projects, the ECCD

conducts watershed-related workshops for teachers, delivers education programs to all levels of students from elementary school to college, and participates in outreach efforts like the Glinodo Earth Force Youth Day. The ECCD also implements the Nutrient Management Program in Erie County, assisting farmers with incorporating best management practices on their farms to reduce agricultural impacts on the watershed.

In August 2002, ECCD's new district office at the Headwaters Conservation Park opened. The building and grounds showcase best management practices for urban areas to reduce nonpoint sources of pollution. For example, erosion and sediment loss has been kept at a minimum by using bioretention basins, a permeable parking lot, a second milled asphalt parking lot, a sediment trap pond with a Faircloth skimmer, vegetated swales and terraces, cement ford stream crossings, and waterway diversions. The result is that less sediment and stormwater runoff enters the Mill Creek watershed, which empties into the Bay.

Erie- Western Pennsylvania Port Authority

As the one of the oldest and busiest ports on the Great Lakes, Erie's harbor and Bayfront have evolved over the past 200 years, changing from a heavily industrialized center to more residential, recreational, and commercial developments. As recently as the 1980s, industry dominated the City's waterfront in the form of bulk and general cargo docks, tank farms, shipbuilding and repair facilities, and a major coal-fired steam generating station (Knight, 2001). Trade shifts over the past two decades have since



Liberty Park

consolidated Erie's waterborne commerce into a dry bulk specialty trade, primarily stone.

The 1991 closure of the Pennsylvania Electric Company's Front Street generating station, which had supplied the community with electricity and steam since 1917, was most likely the biggest catalyst for changing the port's

landscape. The centerpiece of the initial effort was the replacement of the coal-powered generating station with the Erie Maritime Museum, the U.S. Brig Niagara berth, and the Blasco Memorial Library dedicated in 1996, the complex is the anchor for waterfront development. Other changes include a former coal pier that now features luxury condominiums, an abandoned pier that now houses of Liberty Park and a 4,000-seat amphitheater, another unused pier that has become Perry's



Bicentennial Tower

Landing Marina, a 187-foot observation tower built for Erie's Bicentennial Celebration in 1996 on the site of the City's Public Dock (now Dobbins Landing), and a new terminal for cruise boats where there once was a grain elevator.

Public access to the Bay is being greatly increased with a number of new parks, walkways, and fishing piers, as well as the Erie Metropolitan Transit Authority's new intermodal transportation complex, which is providing bus and water taxi service to the waterfront, Presque Isle State Park, and the City.

Erie's waterfront is continuing to re-develop, becoming more focused on tourism and recreation. The Erie-Western Pennsylvania Port

Authority is working with the City of Erie, Erie County, and the State to develop a master plan for revitalization of the waterfront. Over the next few years, a number of development projects at the Port will be completed. Included in that list are the Bayfront Convention Center and Hotel, an industrial warehousing facility, marina expansion, and a recreational vehicle campground.

There is no doubt that the Bayfront area has become a more desirable place to live and visit due to the

dramatic improvements in Presque Isle Bay's water quality and its ecosystem. Public and private investments have followed the Bay's turnaround and will continue to increase as the Bay completes its recovery.

Habitat Enhancement Program

In the early 1990s, the Pennsylvania Fish and Boat Commission was asked for ideas on fish habitat enhancements for the Presque Isle State Park. The Commission suggested constructing coarse brush structures known as Porcupine Brush Cribs. The crib is designed to provide cover to young of year, juvenile and adult gamefish and panfish. Partners for the project include the Park, Save our Native Species of Lake Erie, the Boy



Scouts of America, Pennsylvania Sea Grant, the Department of Conservation and Natural Resources, DEP, Erie Sand and Gravel, the Commission and numerous volunteers. Beginning in 1995, over 700 hours of volunteer time has resulted in the placement of 140 porcupine brush cribs, 35 black bass nesting nurseries, and 167 stake tree brush structures on Presque Isle State Park. The Fish and Boat Commission has stocked the Park's waterworks ponds with trout with help from area school students and over \$7,000 have been spent or donated in materials.

Plans for the future are to place additional structures in the Bay to improve the underwater habitat on the sandy bottom, discuss and possibly revise original plans and continue relations with all partners involved. As of September 2002, an additional 50 porcupine structures and thirty rubble reefs are proposed for further enhancing habitat in the Bay around the Park.

Pennsylvania Sea Grant



Established in 1998, Pennsylvania Sea Grant is a statewide program that supports research and public education programs related to Lake Erie and Pennsylvania's inland waters. Part of the National Sea Grant Network of colleges and

universities nationwide, Pennsylvania's program focuses on two major watersheds: the Lake Erie Watershed, including Presque Isle Bay, and portions of the Delaware Estuary and drainage of the Schuylkill River. The goal of Sea Grant is to increase public awareness of economic and environmental issues related to coastal and inland watersheds.

Pennsylvania's Sea Grant program focuses its efforts in four areas: extension, communication, education, and applied research activities. Extension activities involve developing and addressing priority economic and environmental issues in conjunction with a regional advisory council. These efforts include increasing awareness of aquatic nuisance species like the round goby and their impacts, studying brown bullheads and native mussels in the Bay, and disseminating information on fish consumption advisories.

Communication is centered on sharing research, outreach, and education experiences with local communities and others in the Sea Grant Network to solve problems and explore new uses for the Great Lakes and coastal resources. Pennsylvania's program sponsors a web page and quarterly newsletter, and issues fact sheets on issues like avian botulism, mayflies, and zebra mussels.

Education is a cornerstone of Pennsylvania's Sea Grant program. Focusing on the development of curricula for middle and high school students, Sea Grant seeks to increase environmental stewardship by balancing classroom work with field experience. Through partnership with the Bayfront Center for Maritime Studies and DEP, Sea Grant operates the Environmental Rediscoveries Program, a 2001 recipient of the Governor's Award for Environmental Excellence. While sailing the Bay on the 42-foot Friendship Sloop *Momentum*, students collect samples for water quality analysis. Sea Grant also



Environmental Rediscoveries

supports the Lake-Erie Allegheny Earth Force, a student-centered program that promotes community approaches to solving environmental problems.

Pennsylvania's Sea Grant program also supports a number of small, focused, applied research projects at local universities and colleges in the areas of aquatic nuisance species, native and endangered species, and water quality. Examples of the projects funded include research on the round goby, zebra mussels, and avian botulism.

Through its varied projects and programs, Sea Grant is an important partner in developing the next generation of environmental stewards. Its award winning programs have reached 125 teachers and more than 1,500 students from the tri-county region surrounding Lake Erie in Pennsylvania.

P³ ERIE

Pollution prevention and source reduction



activities continue to be an important component of improving and maintaining a healthy Bay. Concerned with the problems other parts of the Great Lakes were experiencing

due to mercury contamination, representatives of businesses, government organizations, civic organizations, educational institutions and DEP's Office of Pollution Prevention and Compliance Assistance developed the Pollution Prevention

Partnership for Environmental Responsibility in Erie (P³ERIE). A strictly volunteer pollution prevention initiative, P³ERIE's mission is to build support for pollution prevention by developing and implementing a public education campaign and practical projects to reduce the amount of mercury and other persistent toxins that are used and released to the environment in the greater Erie community, especially the Lake Erie watershed.

The partnership was formed in 1997 and supported with funding from the USEPA's Great Lakes National Program Office. In addition to receiving the Governor's Award for Environmental Excellence in 1998 and a Three Rivers Environmental Award for environmental stewardship in 1999, P³ERIE has made great strides in reducing the amount of mercury and pesticides disposed of and released in the Lake Erie Watershed.

Through audits, voluntary mercury reduction programs, education, and collections, P³ERIE's partnership efforts have resulted in the collection and recycling or disposal of approximately 1,975 pounds of mercury and 10,000 pounds of pesticides, implementation of a voluntary mercury reduction program at the largest hospital in northwest Pennsylvania, removal of approximately 180 pounds of mercury during a voluntary audit of the largest wastewater

discharger to the City of Erie's wastewater treatment plant, and collection of approximately 160 varying-sized containers of extremely hazardous chemicals, including mercuric compounds from 14 school laboratories. Additionally, the partnership has published two brochures concerning mercury pollution prevention, sponsored six workshops, and participated in outreach efforts to schools, civic organizations, and professional associations and at community events. P³ERIE is continuing its work to reduce toxics in the Lake Erie Watershed with household hazardous waste collection days, electronics recycling, and a pollution prevention initiative with the Pennsylvania Dental Association.

Presque Isle State Park

Presque Isle peninsula is a migrating sand

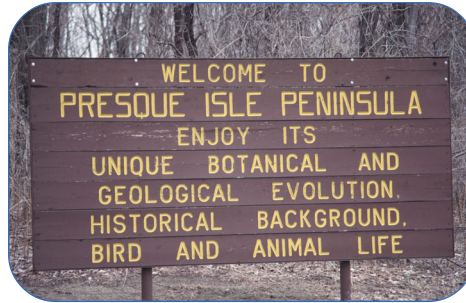


spit jutting into Lake Erie and forming the northern and western border to the Bay. Since 1921, the 3,200-acre

peninsula is home to Presque Isle State Park. One of the most visited of Pennsylvania's State Parks; Presque Isle accommodates approximately four million people each year. The Park provides habitat for varied species of plants, fish, and wildlife. In fact, Presque Isle contains a greater



number of endangered, threatened, and rare species than any other area of comparable size in Pennsylvania. The Park is a National natural Designated Landmark because of its particularly sensitive environment with a constantly evolving shoreline and numerous plants recognized as being of exceptional value (Cosmoss et al., 1999).



In addition to the many environmental and education programs, the Park is an active partner and implementer of projects to improve habitat and protect the plants, fish, and wildlife native to the peninsula. One example is the Park's Invasive Species Control Program. Sponsored by the Presque Isle Partnership and funded through the Great Lakes Protection Fund, this program surveys and removes invasive plant species throughout the Park, protecting the native plants. Another example is the Park's erosion control program. Beginning in 1998 with funding from the Great Lakes Commission, the program uses native plants, bioengineering, and non-conventional erosion control practices like innovative landscape architecture to abate shoreline erosion. Using sand that needed to be removed from an area of the Park along with

downed trees and stumps from the Park, several additional acres of stabilized soil have been put in place along a multi-purpose trail decreasing soil and subsequent nutrient runoff from entering the Bay. The project was completed in 1999 and has been presented multiple times at national conferences addressing shoreline protection.

Strong Vincent High School

Students at Strong Vincent High School conducted a two-year study beginning in 1998 of the sediments entering the Bay from the Cascade Creek Watershed. The study was funded through grants from the Pennsylvania League of Women Voters, the Great Lakes Aquatic Habitat Network and Fund, and International Paper. Preliminary studies indicated elevated levels of PAHs were entering the Bay during rain events. Continued sampling and immunoassay testing of soil samples from severely eroded bank locations indicated that old industrial sites may be contributing to the PAH levels in the Bay. One area located as a potential source of the PAHs was also to become the site of a new commercial building, a convenience store and gas station. With the cooperation of DEP and others, the students assisted in the remediation

by removal of contaminated soil, the building of bank stabilization structures, and the development of a riparian buffer zone.



Streambank stabilization

Watershed Associations

Watershed associations, sporting clubs, and youth groups are the grass roots organizations that do or arrange much of the nonregulatory stream cleanup, monitoring, and education work done in the Bay's watershed. These organizations are very effective in developing and carrying out local solutions to the environmental problems affecting their watershed, involving the local community, and partnering with DEP and others.

The Bay and the streams that drain into the Bay, primarily Mill Creek and Cascade Creek, have benefited greatly from the work of such organizations. Groups like the Pennsylvania Lake Erie Watershed Association (PLEWA), Save our Native Species of Lake Erie

(SONS), Partnership for a Healthy Mill Creek Watershed, and the Erie County Environmental Coalition have all undertaken projects that have improved the Bay and its watershed. While many groups have been in existence for years, their focus has recently broadened or shifted to include environmental work. Some of the most active groups in this watershed were formed within the last two years. They have taken on projects ranging from streambank stabilization and erosion control in Cascade Creek to monitoring macroinvertebrate populations, collecting water quality data, and participating in stream cleanups in Mill Creek and the Bay. A current list of active watershed associations is in Appendix D.

One of the most important services these groups provide is education and outreach to children and young adults. An excellent example of this type of work is Jr PLEWA. Initiated by PLEWA, Lake Erie-Allegheny Earth Force, and Villa Maria Academy, Jr. PLEWA was formed in

September 2001.

Membership consists of students from six Erie high schools, Harborcreek Youth Services, and Explorer Post 808 at Asbury Woods Nature Center. Jr. PLEWA members



Stream Monitoring

learn about water quality monitoring



and watershed issues through actual sampling and analysis and stream cleanup activities.

Part of the national Earth Force program, the Lake Erie-Allegheny chapter has also undertaken projects with local youth that provide hands on experience. All of the Earth Force projects are focused on creating meaningful and sustainable



changes in their communities' environmental policies and practices. Example projects include a pamphlet on the consumption advisory for Lake Erie fish, "Freddy the Fish", that is available in English, Spanish, Russian, Vietnamese, and Bosnian intended to reach the multi-cultural population of Erie; a brochure on preserving Erie's resources, stenciled storm drains; and petitions to raise awareness and support endangered species.

Many other organizations, formal and informal, have played an important part in educating the users of the Bay and the streams that feed it. Stream cleanups, habitat protection and monitoring, and erosion protections are among the many projects these mainly volunteer groups take on. The results are seen in the

improved water quality and heightened awareness and interest in protecting the watershed's resources shown by people who live and work around Presque Isle Bay.

Grants and Financial Assistance

Funding for Presque Isle Bay projects comes from Federal and State grant programs as well as private sources. The projects include education programs for teachers and school children, formation of watershed associations, streambank stabilizations, and monitoring and analysis of the Bay and tributary conditions.

Projects often receive funding from several sources. Funding awarded through four key programs, Growing Greener, Coastal Zone Management, Great Lakes Basin Program for Soil Erosion and Sediment Control, and Great Lakes Protection Fund, is summarized below to provide examples of projects undertaken to assess and improve conditions in the Bay and its tributaries.

Growing Greener

First authorized in 1999, Pennsylvania's Growing Greener program allocates nearly \$240 million in grants for watershed restoration and protection, abandoned mine reclamation, and abandoned oil and gas well plugging projects. Counties, local governments, conservation districts, watershed associations, and other nonprofit groups

involved in watershed restoration and protection are eligible to apply for Growing Greener grants. DEP's Northwest Regional Office has approved 14 grants in the past four years, spending close to \$700,000 on projects impacting the Bay and Lake Erie. A few examples of the types of projects funded through the Growing Greener program are provided below with a complete list of grants awarded in the Lake Erie and Presque Isle Bay Watersheds summarized in Table 1 of Appendix E.

* The Glinodo Earth Force received two grants totaling \$147,339 for education and outreach programs. Twenty projects that directly dealt with watershed protection and restoration were completed. Additionally, more than 70 educators and 1,000 students were trained in watershed issues.



* PLEWA used \$91,000 in grant money to control erosion of the Cascade Creek stream bank near its entry to the Bay. Approximately 250 feet of eroding stream bank was stabilized through the use of gabion baskets and by planting native species of plants and trees.

* \$30,000 is being used to change the Sassafras Street Pier from a storage place for major bulk materials such as sand, gravel, and road salt to a parking lot and shuttle station along the Bayfront Parkway. Proven techniques to encourage natural filtration will reduce the amount of water borne contaminants entering the Bay.



Coastal Zone Management Grants

In response to the increasing pressures of over-development upon the nation's coastal resources, Congress enacted the Coastal Zone Management Act (CZMA) in 1972. The CZMA encourages states to preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife using those habitats. The Coastal Zone Management Program (CZMP) is authorized by the CZMA and administered at the federal level by the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce.

Participation by states is voluntary, however, to encourage states to participate, the act makes federal financial assistance available to any coastal state or territory, including those on the Great Lakes, that is willing to develop and implement a comprehensive coastal management program. Pennsylvania's coastal zone program was approved in 1980 and is administered by the DEP's Office for River Basin Cooperation.

The CZMA authorizes several different grant programs directed primarily at states with an approved coastal zone program. Grants are

available to the states to develop a CZM program, to administer an approved program and develop new program requirements, and to provide technical assistance. States may allocate grants to local governments or other agencies to implement specific or region-wide projects.

Additionally, the CZMA authorizes grants to states to develop programs to address nonpoint sources of pollution. The Coastal Zone Management Fund also established by the CZMA can be used for management issues that are regional in scope, including interstate projects, demonstration projects which have high potential for improving coastal zone management, emergency grants to State coastal zone management agencies to address unforeseen or disaster related circumstance, and recognizing excellence in coastal zone management. Policy areas eligible for grant funding through Pennsylvania's program are listed in Table 3.

Since inception of the program in 1974, the Lake Erie Coastal Zone has received over \$4.6 million in federal funding for 268 projects. DEP has provided an additional \$938,000 and local agencies have provided matching funds of approximately \$6.5 million. The totals include funding for projects in all of the CZMA's grants categories. Examples of the types of projects include:

- Strong Vincent High School received \$8,320 to develop two learning guides and a multimedia presentation on nonpoint sources of pollution using Cascade Creek as the study area.
- The Erie County Health Department was awarded \$20,524 to collect and analyze samples for fecal coliforms from four streams discharging to Lake Erie.
- Erie County received \$4,611 to administer the bluff setback ordinance for eight municipalities.
- Pennsylvania Department of Transportation was awarded \$3,450 to continue its annual effort to monitor impacts to coastal wetlands by using aerial photography of the Lake Erie coastal zone.
- Erie County Conservation District has received several grants over the years to develop and implement public education and outreach programs on nonpoint source pollution, proper use and disposal of toxic substances found in the home, and other related topics.

Table 3. Projects Eligible for Pennsylvania's Grants

Coastal Hazard Areas, which deals with the management of bluff recession and coastal flooding;

Intergovernmental Coordination, which deals with the improvement of intergovernmental coordination with respect to effective management of coastal resources, especially air and water quality, and includes educational efforts regarding coastal concerns.

Dredging and Spoil Disposal, which deals with the *management* of dredging and spoil *disposal* activities;

Historic Sites and Structures, which deals with the preservation, restoration and enhancement of historic sites and structures of coastal significance located within the coastal zones;

Public Access for Recreation, which deals with the provision, enhancement and maximization of public access to and recreation in and along coastal waters;

Wetlands, which deals with the protection, enhancement and creation of coastal wetlands;

Public Involvement, which deals with provision of ample opportunity for coastal publics to participate in the management of coastal resources

Fisheries Management, which deals with the management and enhancement of coastal fisheries;

Port Activities, which deals with the development and enhancement of coastal port infrastructure and the economic base of the urbanized waterfront;

Energy Facilities Placement, which deals with the placement of energy facilities in the coastal zones in an environmentally responsible manner.



In 2001, the CZMP supported 10 projects in the Lake Erie Coastal Zone and nine state agency sponsored projects, contributing \$199,530 and \$377,596, respectively. A summary of these grants is provided in Table 2 of Appendix E. In addition, Congress approved a special fund for the Great Lakes region in December 2000, the Great Lakes Coastal Restoration Fund. In 2002, Pennsylvania received \$1,846,000 from this fund. Eight projects were proposed and are pending approval from NOAA. Proposed projects include purchase of land for preservation of coastal and wetland habitats and development of a greenway.

The Coastal Zone Management Program has financially supported other partnership projects mentioned in this report, such as Presque Isle Partnership and Presque Isle State Park's effort to remove species invasive to the peninsula, the Erie County Conservation District and Penn State's round goby studies, providing an electric motor for Presque Isle State Park pontoon boat tours, and Lake Erie-Allegheny Earth Force's environmental education efforts.

In 1990, Congress amended the Coastal Zone Management Act to tackle nonpoint source pollution problems in coastal waters. Section 6217 requires states and territories with approved CZMPs to develop Coastal Nonpoint Control Programs. Pennsylvania submitted its program

to USEPA and NOAA for approval in 1995. The program describes the region where land and water uses have a significant impact on coastal waters, how nonpoint sources of pollution will be controlled, and enforceable policies and mechanisms to ensure the implementation of the management measures (USEPA, 1996). DEP is currently developing a five-year plan and 15 year implementation strategy for its Coastal Nonpoint Pollution Control Program.

Great Lakes Basin Program for Soil Erosion and Sediment Control

The Coastal Zone Management Program has taken the administrative lead for the Great Lakes Basin Program for Soil Erosion and Sediment Control, providing another source of funds for projects to improve the environmental health of Presque Isle Bay and its tributaries. Managed by the Great Lakes Commission with funding originally from the USEPA and more recently the Natural Resources Conservation Service, this program encourages grants up to \$25,000 with a 25 percent local match of total project costs. Since 1995, Pennsylvania has received 13 grants totaling over \$150,000. Projects have included a watershed assessment for Cascade Creek, several soil erosion control projects along Cascade Creek, beneficial use of



dredged material for shoreline stabilization at Presque Isle State Park, installation of educational best management practices at the Erie County Conservation District's Headwaters Park, and several research efforts by Penn State to improve the effectiveness of sediment basins and dewatering devices.

Great Lakes Protection Fund

The Great Lakes Protection Fund is a private, nonprofit corporation developed to address the ecological problems faced by the Great Lakes. The fund was formed in 1989 by the Governors of most of the Great Lakes states and is a permanent environmental endowment that supports actions to improve the health of the Great Lakes ecosystem. Each of the Great Lakes states committed funding to the endowment; Pennsylvania has invested \$1.5 million.

Part of the endowment income is returned to the state based upon their investment. To date the fund has made 192 grants. Twelve grants worth more than \$250,000 from this fund are supporting projects in Pennsylvania's Lake Erie Watershed. Examples of grants awarded in the Lake Erie and the Presque Isle Bay watersheds are provided below, and a summary of all the grants awarded in this region is provided in Table 3 of Appendix C.

- Gannon University received \$31,637 to quantify and monitor the nonpoint releases of pollution at the mouth of Cascade Creek.
- Funding in the amount of \$7,500 was provided to the Millcreek Township School District to develop a curriculum on invasive species at Presque Isle Bay State Park for students in grades 5 through 10.
- Penn State University received \$16,058 to support its research and study of the round goby in Lake Erie and the Bay.
- The Presque Isle Partnership was awarded \$20,250 to support its program to survey and remove species invasive to Presque Isle State Park.

Monitoring and Studies

While fish and sediment monitoring are essential to ensure that the beneficial use impairments identified for in the RAP are in recovery and being restored, other monitoring and studies are vital to ensure that the pollutant loading to the Bay is decreasing and its health is improving. DEP, the Erie County Health Department, Pennsylvania Sea Grant, and other organizations are committed to continued monitoring and study

of the Bay and sources of its impairments. A few of the ongoing efforts are summarized below.

Air Monitoring

It has been recognized that acid rain and deposition of air pollutants have a negative impact on the Great Lakes. The 1990 Clean Air Act Amendments recognized that a national problem existed with acid deposition. Title IV requires emission reductions of sulfur oxides and nitrogen oxides to decrease acidic deposition. Monitors have indicated that the rainfall acidity has decreased since the implementation of Phase I of Title IV. Further reductions in acid deposition are expected due to implementation of Phase II.

The 1990 Clean Air Act also addressed toxic pollutants under Title III. Title III deals primarily with the control of toxics using Maximum Achievable Control Technology (MACT) followed by an evaluation for residual risk associated with the toxic pollutants. In response to mounting evidence that toxic air pollution contributes to water pollution, Congress enacted

Section 112(m) *Atmospheric Deposition to Great Lakes and Coastal Waters* under the 1990 Clean

Air Act to establish research, reporting, and potential regulatory requirements related to atmospheric deposition of Hazardous Air Pollutants to the Great Lakes. Pennsylvania has put in place the Atmospheric Deposition Network to measure acid rain and acidic deposition. As part of the Network, DEP currently supports nine acid rain and six mercury monitoring sites throughout the state.

To better understand the impact of these airborne toxics and at the urging of the PAC, DEP established an air monitoring station in Presque Isle State Park in July 2000. Air and precipitation samples are collected weekly and analyzed for various metals and particulates. Precipitation samples are analyzed for pH, sulfates, nitrates, ammonium, chlorides, calcium, magnesium,

potassium, and sodium. The monitoring site is now part of the National Atmospheric Deposition Network. Sampling for volatile organic compounds will be started in the near future. The data

collected are being analyzed and DEP is currently unable to draw any specific conclusions regarding



Air Monitoring Station



the type and amount of toxic air pollutants found in the vicinity of the Bay. Monitoring data will eventually be compared with estimated toxic concentrations generated by computer models.

Trophic State Analysis

Pennsylvania requires surveys of its lakes to assess water quality in terms of phosphorus and other nutrient that result in eutrophication. In accordance with Section 95.6 of the Pennsylvania Code, a trophic state analysis involves an evaluation of the trophic status and development of point and nonpoint source control recommendations for nutrients. Studies undertaken by DEP and the Erie County Department of Health in 1990 and 1995, found no nuisance blooms or other excessive growths of algae and dissolved oxygen level were not depleted in the bottom waters of the Bay (DEP, 1991 and DEP, 1998).

Overall, water quality was noted to have improved dramatically. The improvement was attributed to the decrease in phosphorus and other nutrients entering the Bay as a result of the changes to the City of Erie's wastewater treatment, collection, and conveyance system and possibly the reduction in the number of direct discharges to the Bay. Additionally, the appearance of the zebra mussel in the Bay is thought to contribute to the decrease in nutrients. Due to Pennsylvania

Code requirements, periodic trophic surveys will be done on Presque Isle Bay. Such surveys provide another mechanism to monitor and evaluate the health of the Bay.

Presque Isle Bay Watershed Assessment

In July 2000, the Erie County Conservation District began a two-year assessment of the Presque Isle Bay Watershed. Funded under DEP's Growing Greener grant program, the goals of this study are to provide information on the condition of the major streams flowing into the Bay and determine where significant nonpoint source pollution problems exist (Campbell et al., 2002). Researchers from Mercyhurst College, Gannon University, and Penn State's Erie campus conducted a variety of field studies including analysis of the chemical and physical features of sites selected for study, characterization of fish communities, and studies of the benthic macroinvertebrate communities that inhabit the stream bottoms.

The physical and chemical assessment indicated that the loss of streamside riparian habitat is a major factor contributing to degraded water quality in the more developed areas of the watershed. Negative impacts on the fish and benthic macroinvertebrate communities from industrial and urban development were also noted.

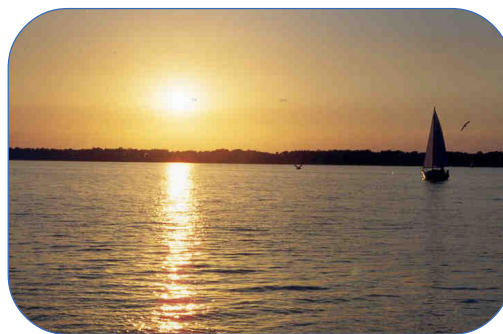


The results of the study are intended to help watershed organizations set restoration goals and site-specific remediation plans. Additionally, the study recommends priority locations for restoration work, establishes standard assessment methodologies and baseline data for monitoring future changes in water quality.



Presque Isle Bay Watershed

CONCLUSION



Presque Isle Bay was designated as an AOC in 1991, however, the United States Department of State did not cite any reasons for its listing. Subsequent analysis of existing data identified two of the IJC's 14 beneficial uses as being impaired: (1) fish tumors and other deformities and (2) restrictions on dredging. Over the next ten years, DEP and its partners focused on the Bay's fish and sediments as the environmental indicators to better define the problems and develop solutions to address these two beneficial use impairments.

Beneficial Use Impairments

Fish Tumors and Other Deformities

The fish tumors and other deformities beneficial use impairment occurs when the incidence rates of fish tumors or other deformities exceed rates at unimpacted control sites or when survey data confirm the presence of liver tumors in bullheads or suckers. Numerous studies have been done on the Bay's brown bullhead population. This species is commonly affected

with surface tumors of the mouth and skin. These growths have been attributed to both viruses and chemical exposure and are known to increase with specimen age. Brown bullheads may also develop liver tumors that are thought related primarily to exposure to chemical carcinogens such as polycyclic aromatic hydrocarbons in the environment.

After 10 years of study, however, the cause of these tumors remains unclear. While there is strong scientific evidence that at least some of the tumors reported in Great Lakes fishes are caused by environmental carcinogens, the studies found little correlation between concentration levels of the environmental contaminants investigated and tumor rates of brown bullheads in the Bay. The studies did find, however, that older bullheads are more likely to have tumors than are younger bullheads. Another consistent observation across studies is that bullheads from both the Bay and reference lakes appear to have a high parasite burden in internal organs, including the liver.



While it has been difficult to directly correlate contamination in the sediments to the incidence of fish tumors, a relationship is believed to exist. Data do support the hypothesis that PAHs may contribute to the high incidence of tumors in the Bay's brown bullhead population.

...the overall health of the brown bullhead population in the Bay has improved; liver tumor rates have decreased to background levels, the population is reproducing, and the population size is stable.

In the early 1990s tumor rates were as high as 86 percent for grossly observable external tumors declining to 19 percent in 1999. The steady reduction in tumor rates is mirrored for external tumors, decreasing over time from a high of 64 percent in 1992 to 17 percent in 1999, and for liver tumors, falling from 22 percent in 1992 to zero percent in 1999. Additionally, the incidence rate of liver tumors in Bay brown bullheads, which are generally considered to be more robust indicators of environmental contamination, were comparable to or below liver tumor rates found in brown bullheads from non-polluted "reference" lakes. The decline in liver tumors rates has been attributed in at least one study to the elimination of the sources of PAHs and other pollution to the Bay.

Based upon these facts, it is reasonable to conclude that the overall health of the brown

bullhead population in the Bay has improved. Liver tumor rates have decreased to background levels, the population is reproducing, and the population size is stable.

Recent studies suggest that the health of the Bay brown bullhead population has improved and that

these fish are in a state of recovery. These facts have led to the recommendation that the beneficial use related to fish tumor and other deformities be considered in a Recovery Stage.

Restrictions on Dredging and Disposal Activities

The restrictions on dredging and disposal activities beneficial use impairment occurs when contaminants in sediments exceed standards, criteria, or guidelines such that there are restrictions on dredging or disposal activities. Much of the discussion regarding this impairment has focused on the potential need for dredging from a remediation and economic standpoint. It is necessary to evaluate the impairment from both the environmental and economic perspectives as they are interrelated.

From the environmental perspective, the 1993 RAP concluded that the levels of sediment



contamination in the Bay resulted in an impairment for dredging. PAHs were identified as the primary contaminant of concern for Bay sediments and found at elevated levels throughout the Bay. Over the years, studies validated the PAH concentrations and also identified heavy metals as contaminants of limited concern. The concentrations of PAHs found in the sediments were higher than that from most coastal environments, including those of the Great Lakes. However, they were not surprisingly or uncommonly high considering the urban nature of the area, and the physical characteristics of the Bay. In general terms, PAH contamination in the Bay resulted from deposition of particles from combustion sources, roadway runoff, combined sewer overflows, and other industrial sources. PAH concentrations were highest in surface sediment on the city side of the Bay, particularly in areas adjacent to the tributaries Cascade Creek, Mill Creek, and the public docks.

Studies conducted over the years have not found a clear indication of impacts on the macroinvertebrates in the Bay attributable to sediment concentrations of PAH and other contaminants. While data does suggest there is an impact on benthic community structure, it is thought that the sediment particle size has more of an effect on habitat than PAH concentrations.

Additionally, the organic nature of the sediments in the Bay reduces the bioavailability of the contaminants. To date there has been no proven correlation shown between Bay sediment contamination and fish tumors.

From an economic perspective, the cost of dredging and disposal must be considered. The Army Corps of Engineers last dredged Presque Isle Bay's inner harbor in the 1970s. Since then, the Corps has limited its dredging to the federal navigation channel at the entrance of the Bay. Based upon an economic analysis and usage, the Corps has no existing or expected plans to dredge the inner harbor or channel for navigational purposes. Therefore, no navigational dredging will take place in locations where there are contaminated sediments present.

Another important economic aspect is the cost of disposal. The cost to dispose of sediments dredged from the Bay will depend upon the concentration of contaminants and the available capacity of the two local facilities accepting dredged material for disposal. Lake Erie does contain a permitted open lake disposal site for uncontaminated dredged sediments. Additionally, a confined disposal facility is located adjacent to the Bay. If the contaminated sediments were dredged at some future time, the proximity of the confined disposal facility may not result in



additional costs for disposal, depending upon the amount of material dredged and the capacity of the disposal facility.

The lack of correlations between PAHs and other contaminant concentrations in the sediments with impacts on the benthic community, the decline in the incidence rate of fish tumors, and the absence of the need for navigational dredging, led to the recommendation that the beneficial use impairment for restrictions on dredging and disposal activities be considered in a Recovery Stage.

Conclusion

One other important factor played a significant role in the decision to recommend changing the designation of the Bay to the Recovery Stage. That is the changes taking place in the Bay's watershed resulting in a decrease in pollutant loading to the Bay. Since the turn of the century, the bay front has been home to numerous industrial operations including a coal fired power plant, a coking facility, and waste disposal facilities. The Bayfront is also a developed, urban area that received high concentrations of nonpoint pollutants from urban runoff, including untreated industrial, commercial, and residential wastewater. The same was true for the tributaries feeding the

Bay, most notably Cascade Creek and Mill Creek.

Changes in the industrial landscape of the bayfront to more recreation and commercial operations, as well as the improvements to the City of Erie's wastewater treatment, collection, and conveyance system, have drastically reduced pollutant loading to the Bay. In addition, the work of both government and private organizations in providing education and outreach and cleaning up the Bay's watershed has reduced the amount of contaminants entering the Bay.

Considering the lack of absolute conclusions from the years of studying the Bay's

Natural recovery will occur over time if new sediments entering the Bay are less contaminated than those present.

brown bullheads and sediments, the success achieved in eliminating point source discharges and combined sewer overflows from the Erie wastewater treatment plant, and the economic evaluations indicating that there is no significant economic reason to dredge within the foreseeable future, the PAC and DEP concluded that the focus of attention and resources should be re-directed toward a watershed approach that stresses



pollution prevention. Instead of continuing to study fish and Bay sediments for remediation purposes, it is apparent that there is more to gain in terms of health of the Bay ecosystem by directing efforts to mitigate sedimentation and nonpoint source pollution within the watershed. Natural recovery will occur over time if new sediments entering the Bay are less contaminated than those present.

The recommendation to designate the Bay in the Recovery Stage does not mean that there is no potential for future remediation. If data collected through ongoing monitoring indicates unacceptable risks to human health or ecological threats, active remediation in the Bay may be necessary. Continued, diligent monitoring of Bay sediments and brown bullhead tumor rates is essential in order to track the progress of natural recovery in Presque Isle Bay.



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Acronyms



AOC	Area of Concern
COD	Chemical Oxygen Demand
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program
ECCD	Erie County Conservation District
ECDH	Erie County Department of Health
GLWQA	Great Lakes Water Quality Agreement
IJC	International Joint Commission
LEL	Lowest Effects Level
P ³ ERIE	Pollution Prevention Partnership for Environmental Responsibility in Erie
PAC	Public Advisory Committee
DEP	Pennsylvania Department of Environmental Protection
PAH	Polyaromatic Hydrocarbons
PEC	Probable Effects Concentrations
PFBC	Pennsylvania Fish and Boat Commission
RAP	Remedial Action Plan
SEL	Severe Effects Level
TEC	Threshold Effects Concentration
TOC	Total Organic Carbon
USEPA	United States Environmental Protection Agency
USFWS	United State Fish and Wildlife Service



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APPENDIX B

Bullhead Monitoring Plan



1. Statement of Purpose

This monitoring plan was developed by the Fish Subcommittee of the Presque Isle Bay Public Advisory Committee as a framework for the long-term monitoring of tumor rates in the Bay's brown bullhead population. Long-term monitoring will provide insight into the temporal stability of the current trend of decreasing neoplasm rates in the brown bullheads and will provide a more robust data set from which to make decisions regarding the impairment status of this beneficial use of the Bay.

2. Project Organization and Responsibility

Project Officer- Jim Grazio, DEP

3. Monitoring Plan Design

3.1. Target Population(s), Collection Method, and Monitoring Period

Presque Isle Bay resident brown bullheads (*Ameiurus nebulosus*) and incidentally collected yellow bullheads (*Ameiurus natalis*) will be monitored annually for the presence of neoplasia for a period of ten years beginning in 2002. Collections will be made using trap netting, electrofishing, and/or angling in accordance with DEP Standardized Biological Field Collection and Laboratory Methods. The index period for these collections will be April through June of each year. *A. nebulosus* and *A. natalis* will also be collected from various inland lakes during the monitoring period for reference purposes per the IJC (1991) list/delist guidelines.

3.2. Monitoring Parameters

Bullhead specimens will be examined annually for the presence of grossly observable external tumors. Histopathological tumor analysis will be also be performed on liver/gall bladder samples and suspected external tumors on a randomly sub-sampled set of fish (see Section 3.3) in 2002, 2003, 2004, 2007 and 2010. Since tumor incidence rates are known to increase with specimen age, pectoral spines and otoliths will be removed from these specimens to determine the age of the fish sampled. Additional data



APPENDIX B

Bullhead Monitoring Plan



related to fish condition will be collected, including specimen length, weight, and presence of other external deformities (e.g., barble deformities, abnormal pigmentation, ulceration etc.). However, in order to ensure data comparability with past surveys, only neoplasm incidence rate data will be used in making beneficial use impairment status decisions.

3.3 Minimum sample sizes

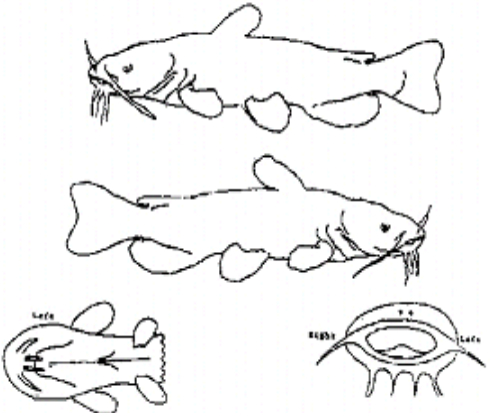
The minimum sample size shall consist of 200 bullheads (or the total sample if $n < 200$) for a given water body for gross observation of external tumors and other deformities. The minimum sub-sample size for histopathological tumor analysis shall be 30 randomly sub-sampled individuals (or the total sample if $n < 30$).

3.4 Data Analysis and Data Quality

Fish specimens will be examined for grossly observable tumors and other deformities by a minimum of two field collectors trained in the identification of bullhead abnormalities, at least one of whom is a professional biologist. Histopathology samples will be preserved in the field in individually labeled containers filled with ten percent buffered formalin and shipped to a qualified animal pathologist for analysis. Spine and otolith samples will be placed in individually labeled scale envelopes and shipped to a qualified technician for aging. Contractors used for histopathology and fish aging services shall provide a copy of their Quality Assurance/Quality Control procedures along with the results of their respective analyses.

3.5 Data Management

Field data for each fish specimen will be recorded on an individual, pre-printed field data sheet (attached). These data will include a unique sample identification number for each specimen, time, date, and location of collection, species name, field biologists present, capture gear, mark-recapture tag number (if applicable), length, weight, and presence of tumors and other deformities. Diagrams depicting the presence of any deformities will also be recorded on the data sheets and digital photographs will be obtained for each specimen. Data will ultimately be transferred to a computer database for analysis and storage.

Presque Isle Bay Fish Tumor Study Fish Health Data Sheet					
Reference Number 2002-	Date: / /	Time: :	Field Observers		
Location	Eaton Reservoir	Lake LeBoeuf	Lake Pleasant	Edinboro Lake	
Presque Isle Bay:		Other:			
Capture Gear Trapnet Electrofishing Angling Other	Species Brown Bullhead Yellow Bullhead Carp Other	Tagging Information Tag Number Recapture Date / / Recapture Location			
Sex: <i>M</i> <i>F</i>	Length (mm)		Weight (grams)		
Aging Technique:		Spines	Otoliths	Other	Age:
Fish Health Information					
Clean ?	Yes <input type="checkbox"/>		No <input type="checkbox"/> (Note Physical Condition Below)		
	*Severity Score				
Barbels	0	1	2	3	Barbels-Notes
Skin Tumor	0	1	2	3	Skin Tumor-Notes
Mouth Tumor	0	1	2	3	Mouth Tumor-Notes
Pigmentation (Yellow)	0	1	2	3	Yellow Pigmentation-Notes
Pigmentation (Black)	0	1	2	3	Black Pigmentation-Notes
Lesions	0	1	2	3	Lesion-Notes
Ulcers	0	1	2	3	Ulcer-Notes
Scars	0	1	2	3	Scars-Notes
Eyes	0	1	2	3	Eyes-Notes
Histopathology	Yes	No		Histopathology-Notes	
Tissue Chemistry	Yes <input type="checkbox"/>	No <input type="checkbox"/>			
		Whole Fish <input type="checkbox"/>	Fillet <input type="checkbox"/>		
				<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> Pictures: Yes <input type="checkbox"/> No <input type="checkbox"/> File # _____ </div> <div> Notes: <div style="font-size: small;"> * 0 No visible maladies * 1 Mild Condition * 2 Moderate * 3 Severe </div> </div>	



APPENDIX C

Sediment Monitoring Plan



1. Statement of Purpose

This monitoring plan overview has been developed as a framework for the long-term monitoring of sediments in the Bay. The main purpose of the plan is to provide verification that the restrictions on dredging beneficial use is no longer impaired due to a continuing natural recovery process in the Bay. In addition, the monitoring plan will provide data that can be used to evaluate the need for future reconsideration of active remediation efforts, and will be flexible to allow for monitoring of emerging contamination concerns. A more-detailed Sampling and Analysis Plan (SAP), which will include detailed QA/QC protocols and analytical details, will be developed for each round of sediment monitoring.

2. Project Organization and Responsibility

Project Officer- Geoff Bristow, DEP

3. Monitoring Plan Design

3.1 Sediment sample locations and sampling frequency

In order to provide data that allows accurate comparison of future sediment conditions to current conditions, sediment sampling will focus on previously sampled locations within the Bay (specific locations will be determined during SAP development). Surficial sediment samples (top four inches) will be collected using petite ponar sampling equipment on a biannual basis for nine years (June 2003 – 2011). This will provide five data sets for trend analysis. The frequency and locations of monitoring beyond 2011 will be determined at that time based upon data trends in conjunction with the results of sedimentation studies and watershed pollution prevention efforts. Sampling data from the US Army Corps of Engineers routine monitoring of sediments within the Federal Navigation Channel will either be added to the data set for a more complete picture of the sediment quality, or, if their data is of sufficient quality and representativeness, their data may help us to eliminate some of our proposed sampling points.

APPENDIX C

Sediment Monitoring Plan



3.2 Monitoring Parameters

Each sediment sample collected will be analyzed for a list of chemicals of concern including PAHs, metals (including arsenic, barium, beryllium, cadmium, copper, mercury, nickel, lead, antimony, and zinc), total organic carbon (TOC) and grain size. This list will be reviewed prior to each sampling event so that modifications to the list can be included in the SAP for each event. Rationale for adding or deleting chemical analysis will also be presented in the SAP. It is proposed at this planning stage that all samples will be analyzed by the DEP Department of Laboratories. However, other laboratory services may be used based upon DEP lab availability and capability for particular parameters. The specific labs for each sampling event will be determined at the time of the SAP development for each event.

3.3 Data analysis and Data Management

Sediment data will be compiled and compared to current conditions for the purpose of evaluating trends in contaminant levels. The baseline for comparison will be the existing sediment data that is discussed in the “Restriction on Dredging Activity” section of this report. Benchmark criteria such as Lowest Effect Levels, Threshold Effect Levels, Severe Effect Levels, or Probable Effect Levels may also be used where they are available and appropriate. Spreadsheets, or other electronic data management tools, will be used to track results.



APPENDIX D

Watershed Associations



Baker Creek Watershed Association
21 South Lake Street
North East, PA 16428
(814) 725-4262

Junior Pennsylvania Lake Erie Watershed Association
Benedictine Sisters of Erie, Inc
DBA Glinodo Center
6101 East Lake Road
Erie, PA 16511

Lake Erie Region Conservancy
2067 West 25th Street
Erie, PA 16502
(814) 453-4018

Partnership for a Healthy Mill Creek Watershed
Mercyhurst College
501 East 38th Street
Erie, PA 16546

Pennsylvania Lake Erie Watershed Association
P.O. Box 1982
Erie, PA 16502-0982
(814) 452-6552

Save Our Native Species of Lake Erie
P.O. Box 3605
Erie, PA 16508
(814) 453-2270

Walnut Creek Watershed Association
3740 W. 26th Street
Erie, PA 16506-2096
(814) 835-5653

APPENDIX E

Summary of Grant Awards



Table 1. Growing Greener Grants

Title	Award Amount	Description
Lake Erie Presque Isle Bay Watershed Project	\$63,364	Sponsored by the Erie County Conservation District, the goals and objectives are to define areas of the Presque Isle Bay tributary streams that are being impaired due to nonpoint source pollution as well as expanding urbanization. These factors have caused aquatic life in the streams to be impacted by the effects of siltation, sedimentation, and loss of stream flow. One of the project deliverables will be a Watershed Restoration Plan. The final objective of the plan will be implementation and placement of devices and technologies to eliminate nonpoint source pollution to the Presque Isle Bay watershed.
Partners for a Healthy Mill Creek (PHMCW)	\$25,000	This grant was for the formation of a new watershed organization focusing on Mill Creek, which flows into Presque Isle Bay. PHMCW recognizes the main components of a healthy watershed: clean air, uncontaminated lands, clean water, and ample opportunities for people to learn about and enjoy the various resources of our environment. Therefore, two primary goals have been established. The first is to increase public awareness about watershed health. The second goal is to provide opportunities for people in the watershed to become involved in projects that will help to restore and improve their environment. The group is now up and running and starting projects in the watershed.
French Creek / Lake Erie Watershed Tree Inventory & Planting Program	\$24,000	This project by the Erie County Department of Planning is categorizing the condition of existing urban trees in targeted areas. Community development does not always occur in areas that protect the safety of the environment. The older developed areas of Erie are constantly affecting urban runoff. Runoff can increase the flow rate of a stream, and this increased flow will affect the rate of stream bank erosion. One proven way to reduce runoff and sedimentation is to plant trees. Many trees are being planted because trees absorb substantial amounts of rainwater and act as a buffer, minimizing the amounts of stream erosion. These efforts will improve, protect, and enhance the watersheds located within the neighborhoods, parks, and recreational areas in the older urbanized communities.



APPENDIX E

Summary of Grant Awards



Table 1. Growing Greener Grants

Title	Award Amount	Description
Pa Lake Erie Watershed Association	\$28,000	Great Lakes water is a threatened resource in terms of both quality and quantity. The Lake Erie watershed has tremendous impact on Presque Isle Bay, which has been identified as an area of concern. Not only does Lake Erie have impacts on the environment, but it also impacts the economy as well. Tourism is one of the main sources of income and employment in Erie County. Previously there was no established watershed in Pennsylvania for Lake Erie. This project established a watershed association, and has begun working to protect, restore, and enhancing one of our critical natural resources.
Junior PA Lake Erie Watershed Association	\$27,158	This project is reaching out to a valuable asset, which is generally overlooked when trying to improve the environment, high school students. The Junior Watershed Association was created to involve over 100 students from at least six high schools. Located in between 3-6 sub-watersheds. Educational opportunities as well as local watershed projects are being used to create public awareness as well as focus on the protection, restoration, and sustainable development of the Pennsylvania Lake Erie Watershed.
Headwaters Conservation Park Natural Resource Center Initiative	\$141,180	The Headwaters Conservation Park has created a Natural Resource Center in order to provide a tangible learning environment that will increase awareness and understanding of the Lake Erie watershed and its subwatersheds, especially Mill Creek. They also hope to promote preservation through environmental education, stewardship, and action by conducting 8 workshops for up to 500 individuals. Target groups for the Center's use include youth groups, Scouting groups, students, teachers, educational institutions, sportsmen clubs, developers, or anyone who has an impact or concern for the watershed and the environment.
Glinodo Center Watershed Education & Watershed Projects	\$114,339 & \$33,000	Glinodo Earth Force was created to help protect, restore, and enhance their local watersheds through educational and outreach programs involving middle school educators and youth. The main goals of these projects were not only to restore and protect the watershed, but also to encourage local youth the become lifelong active citizens who are willing to take responsibility and get involved in addressing environmental issues in their community. These grants allowed for the completion of 20 projects that directly dealt with watershed protection/restoration, and on completion will ultimately train and support over 70 educators and 1,000 youth in watershed issues.

APPENDIX E

Summary of Grant Awards



Table 1. Growing Greener Grants

Title	Award Amount	Description
Country Fair Stabilization	\$91,300	This project was completed by the PA Lake Erie Watershed Association on a section of Cascade Creek, near its entry to Presque Isle Bay. The goal of this project is to control erosion of the Cascade Creek stream bank and the disbursement of sediments. The removal of debris, tree stumps that had fallen into the creek, and excess sediment will help with the flooding that occurs during periods of heavy rain. Approximately 250 feet of eroding stream bank was stabilized thru the use of gabion baskets and by planting native species of plants and trees. This will lessen the amounts of sediment in the water, as well as reduce the disruption of aquatic habitats.
The Cascade Creek Wetlands Restoration	\$25,000	This project was awarded to the Erie Western Pa Port Authority. At the mouth of Cascade Creek lies one of the few remaining coastal wetlands on Lake Erie. This eighteen-acre wetland serves as a valuable habitat for several species of plants, animals, and aquatic organisms. Given its proximity to the city of Erie, human contact has impaired the wetlands. The first phase of this project will include identifying, mapping and removing exotic plant species found throughout the wetland. Invasive plants will then be removed. Next, native plant and tree species will be re-introduced, as well as monitoring the success of phase one. This will help to improve sediment filtration and improve habitats for mammals, birds, fish, and other wildlife.
Cascade Creek Bank Stabilization	\$25,000	Cascade Creek has suffered from industrial pollutants as well as other urban-related degradation. While many point source pollutants have been eliminated, Cascade Creek still experiences problems due to eroding stream banks and sedimentation, which result in degraded water quality and the inability to filter contaminants. The main components of this project included the repair of eroding stream banks through bioengineering techniques, and a regional workshop, which educated other watershed stakeholders about this alternative approach to erosion. The Erie Western PA Port Authority completed this project.
Cascade Creek Assessment	\$25,000	The Erie Western Pa Port Authority is contracting with an engineering team to analyze the flow of Cascade Creek to determine the best strategies for reducing the damaging soil erosion, sedimentation and other negative impacts significant rain events have on this urban tributary to Presque Isle. The project, upon completion, will produce a restoration plan outlining the strategy and location for possible stormwater BMP solutions.



APPENDIX E

Summary of Grant Awards



Table 1. Growing Greener Grants

Title	Award Amount	Description
Alternative Lawn Care	\$11,000	Over 67 million pounds of pesticides are applied on lawns each year, and use is increasing 5-8% annually. Not many homeowners are well versed in natural lawn care, which uses minimal or no pesticides. The objective is to inform the general public about methods of lawn care that are less destructive to the environment. Brochures have been updated, and seminars have been held to inform the public of the dangers of pesticides to human and environmental health.
Sassafras Pier Nonpoint Source Pollution Prevention	\$30,000	The Sassafras Street Pier is a man-made pier located on Erie's Presque Isle Bay that has been the site of major bulk materials such as sand, gravel, and road salt. These materials will be removed and this land will be redeveloped into a modest parking lot and bus shuttle station on the portion abutting the Bayfront Parkway. Also incorporated will be proven techniques which significantly reduce any water borne contaminants that may degrade the bay. The parking area will drain stormwater through a natural filtration area before it enters the groundwater system and, ultimately, Presque Isle Bay.

APPENDIX E

Summary of Grant Awards



Table 2. Coastal Zone Management Grants

Title	Award Amount	Description
LAKE ERIE ZONE PROJECTS		
Lake Erie Costal Zone Coordination and Technical Assistance	\$20,000	The Erie County Department of Planning will use regional coordination to help implement the CZM Program on a day-to-day basis. Provides technical and clerical support to the Lake Erie Costal Zone Steering Committee and local contract/project administration and general technical assistance to the costal municipalities.
Bluff Recession and Setback Ordinance Administration	\$1,000	Several Erie County Townships are seeking administration of the bluff setback ordinances for each municipality including monitoring the bluff setback distance of new structures, monitoring improvements to existing structures and maintaining a variance procedure and records of all permit/non-permit actions within the municipalities bluff recession hazard area.
Walnut Creek Watershed Environmental Education	\$19,850	Millcreek School District will sponsor a program of environmental education for teachers, students, senior volunteers, and others, revolving around the Walnut Creek Watershed
Lake Erie Shipwreck Study	\$33,505	The Bayfront Center for Marine Studies will be responsible for the mapping, marking, inventory, inspection and study of various shipwrecks in Lake Erie.
Glinodo Environmental Education	\$30,000	Glinodo Environmental Education Center hosts environmental education for school children and their teachers, with regard to environmental concerns within the Lake Erie Costal Zone.
Flagship Niagara League Museum Exhibit and Video Tape Presentations	\$7,775	FNL will prepare of two video taped presentations to be used at the Erie maritime Museum, and the purchase of a display case and interpretive panels for a model of the U.S.S. Wolverine.
Coastal Mapping Project	\$6,500	The Erie County Department of Planning will be responsible for the preparation of a base map, containing tax parcel delineation, and zoning information for three coastal municipalities.
Liberty Park Improvements	\$50,000	The installation of a waterfront overlook, an access drive, and associated landscaping and fencing at Liberty Park. The Erie-Western Pennsylvania Port Authority will oversee this project.



APPENDIX E

Summary of Grant Awards



Table 2. Coastal Zone Management Grants

Title	Award Amount	Description
Springfield Township Comprehensive Plan	\$18,000	The preparation of a comprehensive plan for Springfield Township by the Erie County Department of Planning.
Invasive Plant Species Project 2002	\$12,900	In response to the need for preserving biodiversity within Presque Isle State Park, the Presque Isle Partnership has undertaken a long-term project to control invasive plant species threatening plants native to the park. In 1998, the Partnership began a series of work projects designed to conduct initial surveys and test invasive species control methods. The Partnership has employed interns, under supervision of a Mercyhurst College professor, to conduct work. Great Lakes Restoration Grant finds would be used to hire two additional interns to assist in ongoing efforts to control invasive species in Presque Isle State Park.
STATE AGENCY PROJECTS		
Roderick Wildlife Preserve Improvements	\$50,000	Various improvements to be made to wildlife habitat at State Gamelands 314, and associated public information activities in Erie County's Springfield Township.
Vineyard Composting Study	\$49,975	A scientific examination conducted by Penn State University regarding the use of composting, in place of the less environmentally friendly application of chemicals in the cultivation of wine grapes in the Lake Erie Coastal Zone
Costal Zone Wetland Monitoring Update- Aerial Photography	\$0	The CZM Program, through Pennsylvania Department of Transportation continues its annual efforts to monitor impacts to coastal wetlands, by taking and interpreting infrared aerial photography of both coastal zones
Lake Erie Coastal Zone Monitoring Overflights	\$0	The project includes Lake Erie Coastal Zone Monitoring overflights for federal, state, and local permitting agencies to obtain a birds-eye view to detect possible violations.
Erie Cruise Terminal	\$200,000	This project will provide PennPorts the necessary support for the overall Erie Cruise Terminal construction through building and infrastructure improvements.
Agricultural Preservation	\$12,650	The purchase of development rights to coastal, agricultural land by the Erie County Department of Planning.



APPENDIX E

Summary of Grant Awards



Table 2. Coastal Zone Management Grants

Title	Award Amount	Description
Lake Erie Bluff Evaluation Study	\$12,650	Wetland and Costal Resources, INC. have been retained by to utilize modern methodologies to determine existing and potential Bluff Recession Hazard Areas along the Pennsylvania coastline of Lake Erie.
Coastal Heritage Tourism Plan	\$20,000	Provide funding to DCNR to help defray cost in the development of the Coastal Heritage Tourism Plan in the coastal zones.
Round Goby Impacts on PA's Aquatic Resources	\$32,321	This project will be carried out by the Erie County Conservation District, to research the population dynamics of the round goby; evaluate the interactions of the round goby with native species; analyze the toxicological implications of the round goby as both a predator and prey, especially related to consumption of zebra mussels and consumption by important Pennsylvania game species



APPENDIX E

Summary of Grant Awards



Table 3. Great Lakes Protection Fund Grants

Title	Award Amount	Description
Environmental Rediscovery of Presque Isle Bay.	\$35,625	Sponsored by the Bayfront Center for Maritime Studies and Sea Grant, this program provides hands-on environmental education to inner city, disadvantaged, and "at risk" youth. The curriculum is focused on the health of Presque Isle Bay and incorporates the Friendship Sloop Momentum as part of the sampling and study of the Bay.
Monitoring non-point source pollution	\$31,637	Gannon University sponsored this project to quantify the non-point release of pollutants to Presque Isle Bay. A monitoring station was placed near the mouth of Cascade Creek and samples analyzed for a list of water quality parameters.
Glinodo Center	\$3,400	Funding supported the participation of 15 students and 5 teachers from Erie in the Fourth Biennial Great Lakes Student Summit "Great Lakes, Great Lakes".
Lake Erie Millennium Plan	\$8,400	Sponsored by the Great Lakes Institute for Environmental Research, the National Water Research Institute, the Ohio State University Stone Lab, and the United States Environmental Protection Agency's Grosse Ile Laboratory, this grant supports eight 2-day workshops focusing on contaminants in Lake Erie.
Millcreek Township Environmental Education	\$7,500	Funding was provided for the development of a curriculum on invasive species on Presque Isle State Park for Millcreek Township School District students in grades 5 through 10.
Watershed Education and Protection through microscale chemistry	\$45,000	Sponsored by the Northwest Tri-County Intermediate Unit, the grant provided funds to equip three school districts with microscale chemistry kits and professional development of teachers.
Gannon University Summer School	\$20,000	Gannon University, the Northwest Tri-County Intermediate Unit, and the Governor's Regional School of excellence use this grant to support a summer education program titled, "Investigating and Researching Environmental Health Problems".
Alternative on-lot wastewater system	\$7,000	Funding was provided to the Penn Soil Resource Conservation and Development to design and install an alternative on-lot wastewater system that addresses low flow and gravity fed conditions.



APPENDIX E

Summary of Grant Awards



Table 3. Great Lakes Protection Fund Grants

Title	Award Amount	Description
Bayfront Center for Maritime Studies	\$54,451	Sponsored by the Pennsylvania Sea Grant and Penn State University, this grant provide funding to support and enhance the Bayfront Center for Maritime Studies Environmental Rediscoveries Program and development of a companion program, the Lake Erie Aquatics Program.
Round Goby Study	\$16,058	This grant supports Penn State University's research and study of the Round Goby fish in Lake Erie.
Invasive Species Control Program	\$20,250	Sponsored by the Presque Isle Partnership, this grant supports the survey and removal of species invasive to the Presque Isle State Park.
Curriculum Development Workshops	\$4,400	Sponsored by the Pennsylvania Sea Grant and the Penn State University, funding is being used to coordinate and deliver tow curriculum development workshops for local teacher on Presque Isle's ecosystem.